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Fish Meal Market Review

Economic and Commercial Analysis
Report No. 28

Fisheries and Oceans | Pêches et Océans

Canada

Fish Meal Market Review

Market Analysis Group
Commercial and Market Analysis Division
Economic and Commercial Analysis Directorate
Department of Fisheries and Oceans
Ottawa, Ontario
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May, 1989

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FOREWORD

This study was commissioned by the Economic and Commercial Analysis Directorate in order to gain insight into the ever changing world fishmeal market.

The report contains valuable information on production, consumption, imports and exports, as well as some interesting relationships on world prices of fishmeal and fishmeal substitutes. Background information on the uses and types of fishmeal should also be helpful to those interested in this industry.

PRÉFACE

Cette étude a été commandée par la Direction générale de l'analyse économique et commerciale afin d'acquérir des connaissances sur le marché mondial en constante évolution de la farine de poisson.

Ce rapport contient des renseignements précieux sur la production, la consommation, les importations et les exportations ainsi que d'intéressantes corrélations entre les prix mondiaux de la farine de poisson et ses substituts. Les données antérieures concernant l'utilisation et les différents types de farine seront à ceux que cette industrie intéresse.

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1. INTRODUCTION

1.1 The Fish Meal Review Contract

The Market Analysis Group of the Department of Fisheries and Oceans (DFO) contracted GTA Fisheries Consultants Ltd. to undertake a study of fish meal markets. The objective of the study was to document and analyze trends in world-wide fish meal markets. The study was designed to provide DFO with the information required to project fish meal prices and anticipated marketing trends.

1.2 Information Layout

This study is divided into six chapters. Chapter two introduces the reader to markets for fish meal and substitute meals. The nature of the product and its application in the feed industry are discussed. Chapter 3 reviews world-wide market trends for fish meal over the 1977 to 1987 period. Important trends and factors affecting prices are analyzed. Chapter 4 updates the market situation for 1988 and the first quarter of 1989. Chapter 5 deals with the projection of fish meal prices. Chapter 6 reviews the situation of and prospects for the Canadian fish meal industry.

Please note that all prices are stated in United States dollars (US$), unless otherwise noted.

2. FISH MEAL

2.1 Introduction

Fish meal is a protein commodity sold on world markets. "It is used as a high protein supplement most commonly mixed with corn, soybean, or cottonseed meal; meat byproduct meal; and vitamins and minerals for feeding to broilers, layers and turkeys. Fish meal is also used in feeds for mink and other fur-bearing animals, farmed fish, laboratory animals, livestock, and house hold pets. Fish has a particularly high concentration of the amino acids lysine and methionine." (D.D.Huppert, 1979)

2.1.1 The Product

There are three general categories of fin fish meal, based on the percentage of protein in the meal. These are: greater than 70%, 64-69%, and 60%. These fish meal protein percentages compare favorably with shrimp meal (51%), crab meal (38%), meat & bone meal (47%), and soybean meal (45%).

Meals having a protein percentage above 70% are made from herring or capelin. The composition of fall herring in Atlantic Canada is 18% protein, 11% oil, 2% ash, and 70% water.[1] The fish meal produced from herring is noted for its high protein content (approx. 74%) and low ash content (10-12%). The protein and ash values change dramatically if the fish have been filleted. Protein percentage drops to approximately 66% and ash content

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[1] FAO Fisheries Technical Paper 142, Rev.1, p.3.

increases. The primary use for herring meal is aquaculture, but, it is also good for mink feed.

The middle class of fish meals contains between 64% and 69% protein. Included in this category are anchovy and sardine meals from South America, anchovy and pilchard meals from South Africa, and whole white-fish of various origins. These fish have 50-100% more ash content than herring meal. Meals made from these fish make up the bulk of fish meal production today.

The lower percentage (60%) protein meals are made from a mix of several fish species, redfish and pollock for example, or from white fish (cod, flounder, haddock) that have had the fillet removed. This meal usually has a high percentage of ash (bone). Menhaden, the primary industrial fish used by United States fish meal producers, is also in this fish meal category, but it has a high oil content and normal ash content.

2.1.2 Product Attributes and Quality Considerations

Each type of fish meal has a different chemical composition which defines its food value for specific markets. While protein percentage is the major characteristic that defines the value of fish meal, the quality of this protein is important as well. For example, whole fish protein is superior to byproduct protein (fish carcass with fillet removed). By filleting the fish, much of the usable protein is removed. A second variable is the boniness of the fish, which raises the ash content (calcium and phosphorous from the bones) of the meal. Ash has no use in

aquaculture feeds. In addition to contributing protein, fish meals also contribute lysine and methionine amino acids, nutrients which are particularly crucial to fish growth.

An essential treatment for dried meal is the addition of an antioxidant to chemically stabilize the product. This prevents salmonella growth during storage time and transportation.

An important factor that affects fish meal quality is the time between catch and processing. Aquaculture feed producers demand fish meal that is manufactured within 24 hours of harvesting. The biological deterioration that begins soon after harvest reduces the nutrient value of the whole fish. This deterioration is significant if storage time is prolonged or the fish is not chilled to slow down the breakdown process. Aquaculture feed producers demand a raw product in essentially the same condition as would a processor of human food products.

The processing of herring offal into meal within 24 hours of harvest is not possible when the Atlantic coast herring season is in progress. During this season, when glut landings are normal, holding offal up to three to five days (depending on ambient temperatures) is considered acceptable by the processors; often they have no choice. A large meal plant, operating 24 hours per day, cannot process all the offal it receives within that time period during glut landings.

Traditionally, fish processors have considered offal a waste by-product that isn't worthy of additional investment. Most herring roe processors are happy to truck the offal out, at their

cost, so that they don't have to find an alternative means of disposal. Meal processors are reluctant to pay for an easily obtainable raw product, so suppliers deliver the offal by truck without proper icing. Delivery costs are minimized, but so is product quality. This problem can not easily be solved under existing circumstances.

A major fish feed producer from Vancouver commented that east coast meal has an image of poorer quality because high standards are not followed. While some companies may have a good product in general, individual plants within the company may provide substandard meal. The fish processor's perception of offal as a by-product results in poor handling and processing techniques. The processor may be using out-dated or inefficient equipment, which keeps the product quality low. Many east coast plants will only sign a contract specifying that delivery is subject-to-production, which may fluctuate widely. Most fish feed producers prefer guaranteed quality and delivery, which is available from the large meal producers in South America. South American companies are noted for producing a high quality, whole fish meal with guaranteed delivery.

The new Moore Clarke Canada fish feed plant to be built in St. Andrews, N.B. will not buy Canadian-made fish meal. A representative said that the quality of the meal was not sufficient to meet their standards.

2.2 Applications

2.2.1 Aquaculture Feed

The end use of fish meal is often determined by the freshness of the fish when it is processed and the method of drying used. Higher standards are demanded for aquaculture feeds than for agricultural feeds. Therefore, meals made from fresh fish that have been dried at low temperatures are optimum for this industry. The Norwegian fish meal industry is the leader in setting quality standards so as to satisfy the local salmon farming industry.

Fish meal is preferred to vegetable meals in aquaculture because of its higher protein percentage, high quality nutrients, low oil content, and good flavour and odour. The amino acids naturally present in fish meal are essential for proper fish growth. In particular, trout need a minimum of 30% fish meal in their feed and salmon need 35-40%. The total protein content of salmon feed is 50% in starter fish and not less than 40% in older fish. Salmon cannot be fed large volumes of soybean meal because they don't like the flavour.

Herring meal is often used in aquaculture because of its low ash content and having the highest protein content compared to other fish meals. Fish do not need the essential minerals found in ash as much as poultry, pigs and other animals. Therefore, the fish feed manufacturer obtains more value for his money if herring meal is purchased.

2.2.2 Animal Feeds

Protein meals are used in a wide variety of animal foods. The largest markets are poultry and pig feeds. About 80% of the fish meal consumed in the United States goes into poultry feed. (D.D.Huppert, 1979). Smaller markets are feeds for cattle, fur-bearing animals, and pet foods. Fish meal is used as a component in these feed applications also, but in smaller quantities.

Fish meal is noted as a source of protein, minerals, vitamins, and essential fatty acids. Fish meal is preferred over vegetable meals in certain animal feeds because of its higher quality protein and fat.

> "The composition of fat in fish meal differs from most vegetable oils because it contains high levels of long chain (C20 and greater) polyunsaturated fatty acids. All the energy in fish meal comes from its content of protein and fat. Feeding trials have shown that fish meal in the diet of an animal can lead to increased growth and egg production, improved reproduction and better feed conversion, compared with nutritionally balanced all-vegetable diets. This is thought to be due to the presence of so-called unknown growth factors (UGF). Therefore, many feed formulators insure a minimum incorporation of fish meal in pig and poultry diets."[2]

Fish protein is recommended for both pig and poultry diets in these amounts: 4-15% for poultry diets and between 4-12% for pig diets[3]. The level depends on the growth stage of the animal and the fat content of the fish meal. Relatively high proportions of fish meal in animals lead to a fishy taste, so

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[2] S.M.Barlow & M.L.Windsor, Fishery By-products - IAFMM Technical Bulletin No.19, International Association of Fish Meal Manufacturers, September 1984, p.2.

[3] Ibid, p.17.

fish meal percentages must be kept low. Fish meal is not used in dairy cattle at all due to the off-taste produced in milk.

Although fish meal has a high level of protein and other nutrients that promote rapid growth in animals, these nutrients can be supplied by soybean meal in combination with synthetic supplements if fish meal prices become too high. Feed manufacturers use microcomputer-based analysis programs to determine which protein meals to buy given constraints on meal quality, protein percentage, cost, etc. When the price of fish meal goes above a specified level, the program tells the feed producer the optimal percentage of vegetable meal substitution that will provide a similar product at lower cost. In this way the feed maker can maximize product quality and minimize cost of production.

2.2.3 Emergence of Specialized Markets

The rapid development of various aquaculture species around the world has spurred research into optimum dietary formulae. This research shows that the quantity and type of fish meal used varies for individual species. A constant throughout is the freshness of the meal. Markets are developing world-wide for high quality, fresh fish meals to be used exclusively in aquaculture diets.

2.3 Price Determination

The price of fish meal is dependent primarily on its protein content, thus allowing this protein source to be compared to any other on an equivalent basis. This helps a buyer to decide between one tonne of soybean meal having a 44% protein content and one tonne fish meal having 65% protein.

Fish meal is sold in North America by protein unit, or percentage point. For example, if the price of a protein unit was quoted at $10.50 and herring meal consisted of 74% protein, the value of one tonne would be $777.00 ($10.50 x .74 x 100) or about $.35 per pound. Chile and Peru export on a per tonne basis, which often gets converted into a protein unit basis by Canadian brokers.

Many other factors, such as protein quality and ash content, play a role as well in helping the buyer to decide on the best deal available in the market. A high ash content adds no value to the meal used in fish feed as both calcium and phosphorous are already present in seawater. Some drying processes reduce the amount of amino acids in fish meal, therefore reducing the value of the meal. Some other factors that the buyer takes into consideration are the freshness of the fish before processing and whether antioxidants were used to stabilize the dried meal.

3. REVIEW OF 1977-1987 MARKET SITUATION

The world-wide review of fish meal is based on the United Nations' Food and Agriculture Organization (FAO) statistics for the years 1977 to 1986. Information for 1987 came from the FAO and the United States Department of Agriculture (USDA). A review of world trends in production, consumption, imports, exports, and prices of fish meal over the 1982 to 1987 period will be presented.

Each section has data from 1987 compared to the previous five year (1982-86) average. The top ten countries in each section are ranked according to the 1982 to 1986 averages. The ranking for 1987 (1988 for production only) is listed to the left of the country names.

3.1 Production

3.1.1 Description

Fish meal production by major producing country is shown in Exhibit 1. See page I-3 in Appendix I for a complete profile of world production over the period 1977-1988.

EXHIBIT 1

FISH MEAL PRODUCTION

x 1,000 MT

1988 RANK	MAJOR PRODUCERS	1982-86	%	1986	%	1987	%	1988#	%
	World total	5,938.6		6,661.3		6,168.0		6,275.7	
1	Japan	1,149.2	19%	1,179.1	18%	1,112.7	18%	1,170.0	19%
3	Chile	1,008.0	17%	1,282.4	19%	1,047.0	17%	1,078.0*	17%
4	USSR	656.6	11%	746.5	11%	766.6	12%	750.0	12%
2	Peru	635.2	11%	973.1	15%	747.0	12%	1,090.0*	17%
5	USA	460.7	8%	407.1	6%	470.0	8%	357.0*	6%
6	Denmark	311.4	5%	307.8	5%	270.0	4%	338.0*	5%
10	Norway	270.0	5%	194.1	3%	186.0	3%	184.0*	3%
8	Thailand	214.9	4%	215.0	3%	217.0	4%	216.0	3%
	Ecuador	149.0	3%	205.8	3%	116.7	2%	132.0	2%
7	South Africa	133.9	2%	124.4	2%	289.0	5%	235.0*	4%
	subtotal:	4,989.0	84%	5,635.3	85%	5,222.0	85%	5,550.0	88%
	Canada	63.3	1.1%	61.2	1.0%	64.5	1.0%	67.0	1.1%
9	Iceland			178.0	3%	171.0	3%	189.0	3%

The starred numbers for 1988 are based on data from the International Association of Fish Meal Manufacturers (IAFMM). The other numbers are estimates based on USDA and Oil World figures.

World production of fish meal averaged approximately 5.6 million metric tons (MMT) over the ten year period 1978-1987. Production has been increasing with average production over the five year period 1982-1986 standing at about 5.9 MMT. Production climbed to almost 6.7 MMT in 1986, but fell slightly in 1987 to 6.2 MMT. Although complete data are not available for 1988, world production of fish meal is estimated at 6.3 MMT.

The vast majority (about 95%) of a fish meal production comes from oily fish such as anchovies, sardines, mackerel, herring and

menhaden. Fish meal derived from ground fish accounts for only about 3% of total world supply.

Ten countries accounted for 84% of fish meal production over the period 1982-1986[4]. Japan was the largest producer accounting for 19% of production over this period. The South American countries of Chile, with 17% of production, and Peru, with 11%, also were major fish meal producers. The USSR contributed 11% of total production while the U.S.A. rounded out the top five producers with 8% of total production. Other countries included in the top ten producers were, in descending order: Denmark (5%), Norway (5%), Thailand (4%), Ecuador (3%) and Iceland (2%). Canada accounted for 1.1% of the world wide production of fish meal over the 1982-1986 period.

Several changes occur in 1987 and 1988. South Africa's production rose almost 85% over its 1982-86 level, and Peru's was up by 72%. Both the U.S. and Norwegian production levels dropped well below the 1982-86 average.

3.1.2 Analysis

The most notable trends in the relative contribution of countries to world-wide production of fish meal have been the rise in Chile as a major producer and the decline of Norway. In 1977, Chile accounted for about 5.6 % of fish meal production. By 1986, Chile's contribution to total production had risen to over 19%. It

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[4] This period, 1982-1986, is used so that production may be compared with consumption, imports and exports using FAO data. Some figures are estimated for 1987 and 1988.

has leveled off now at 16-17%. Norway produced slightly over 10% of total fish meal in 1977, but its contribution dropped to just under 3% by 1986. Norway's production has declined by 45% from 1983 to 1987. Its production stabilized in 1988 at 184,000 MT. Also of note is South Africa's production increase of 132% in 1987 compared to 1986, due to a large pilchard harvest. Its 1988 output dropped 19%, but it is still well above 1986 production levels.

3.2 Consumption

3.2.1 Description

Fish meal consumption by major consuming country is shown in Exhibit 2. See pages I-4 to I-7 in Appendix I for a complete profile of world consumption over the period 1977-1986. The consumption figures are derived by adding production and imports, then subtracting exports. This was necessary due to the lack of consistent data on consumption. Data from different sources rarely match.

EXHIBIT 2

FISH MEAL CONSUMPTION

x 1,000 MT

1987 RANK	MAJOR CONSUMERS	1982-86	%	1986	%	1987#	%
	World total	5,874.0		6,651.0		6,233.0	
1	Japan	1,102.7	19%	1,173.4	18%	1,117.7	18%
2	USSR	692.9	12%	823.5	12%	826.6	13%
3	USA	549.4	9%	540.3	8%	586.0	9%
5	UK	253.4	4%	277.1	4%	290.0	5%
7	West Germany	206.4	4%	287.5	4%	230.0	4%
9	South Africa	197.7	3%	192.4	3%	150.0	2%
6	China	169.9	3%	243.7	4%	280.0	4%
4	Peru	157.1	3%	294.1	4%	300.0	5%
	Sweden	126.7	2%	117.7	2%	90.0	1%
10	Yugoslavia	101.3	2%	117.1	2%	100.0	2%
	subtotal:	3,557.6	61%	4,066.8	61%	3,970.3	64%
	Canada	42.1	0.7%	50.5	0.8%	45.4	0.7%
8	Taiwan					210.0	3%

All numbers are based on the formula: production + imports-exports = consumption. There is no allowance for inventory change.

World consumption of fish meal averaged about 5.6 MMT over the ten year period 1978-1987. Consumption averages 6.1 MMT in the 1983-87 period compared to a 5.1 MMT average for the 1978-82 period.

Ten countries accounted for 61% of fish meal consumption over the period 1982-1986. Consumption is much more dispersed world-wide than production. Japan is the largest consumer (as well as producer), accounting for 19% of world consumption over this period. The USA and USSR are follow with 12% and 9% of consumption, respectively. There is a gradual decline in the next

seven countries, plus several that closely follow the tenth on this list. Canada accounted for less than 1% of the world wide consumption of fish meal over the 1982-1986 period.

The major change in consumption patterns to occur over the 1977 to 1986 period is the emergence of China as a major consumer. China consumed virtually nothing in 1977, but 4% of the total production in 1986. Recent figures from the USDA show that this number has risen to 6.5% in 1988. Norway and Peru increased their share of world consumption by 2%, from 0% to 2% and 1% to 3%, respectively. Both West Germany and the United Kingdom have decreased their relative share of world consumption by 2%, from 6% of the world total to 4% each.

3.2.2 Analysis

World consumption of fish meal has increased by 40% over the period 1977 to 1986. The major consumers, Japan, USSR, and USA have maintained their respective 1-2-3 positions over the past six years. Both the USSR (40%) and USA (33%) have shown appreciable gains in consumption over the ten year period.

The most notable trend in the relative consumption of fish meal has been the increase in consumption by China, which has gone from virtually zero consumption to 244,000 MT in 1986. China uses fish meal in its poultry, fish, and shrimp farming operations.

The large consumption increases occurring in both Norway and Peru are attributable to their development of huge salmon farming industries. Norway's consumption went from 3,500 MT in 1977 to

101,000 MT in 1986. Peru's consumption increased from 55,000 MT in 1977 to 295,000 MT in 1986. However, Peru's meal stocks were well above average in 1986 due to lower exports. Therefore, their consumption increase is estimated to be 200% over the ten year period.

Smaller consuming countries with significant increases were the Netherlands (100%) and Yugoslavia (45%). Sweden had a total gain of 46% over the ten years, but, its consumption has fallen since 1983 and latest figures indicate this trend is continuing.

3.3 Exports

3.3.1 Description

Fish meal exports by major exporting country are shown in Exhibit 3. See page I-8 in Appendix I for a complete profile of world exports over the period 1977-1986.

EXHIBIT 3

FISH MEAL EXPORTS

x 1,000 MT

	World total	2,823.7		3,253.0		3,100.0	
1987 RANK	MAJOR EXPORTERS	1982-86	%	1986	%	1987#	%
1	Chile	900.0	32%	1,081.6	33%	1,096.0	35%
2	Peru	478.0	17%	679.0	21%	730.0	24%
3	Denmark	250.3	9%	230.5	7%	210.0	7%
4	Germany FR	211.2	7%	220.7	7%	205.0	7%
9	Norway	205.3	7%	92.3	3%	80.0	3%
5	Japan	135.0	5%	167.2	5%	200.0	6%
8	Ecuador	126.8	4%	176.5	5%	90.0	3%
7	Thailand	126.3	4%	141.8	4%	130.0	4%
6	Iceland	121.2	4%	192.1	6%	160.0	5%
10	USA	34.2	1%	34.9	1%	64.0	2%
	subtotal:	2,588.4	92%	3,016.6	93%	2,965.0	96%
	Canada	24.0	0.9%	20.0	0.6%	23.4	0.8%

1987 numbers are estimates based on FAO and USDA data.

Some countries produce more fish meal than they consume and export the surplus. The South American countries of Chile and Peru dominated fish meal exports over the 1982 to 1986 period. Together, these countries accounted for about 50% of world exports with Chile contributing 32% and Peru 17%. Other important exporters over the 1982 to 1986 period were Denmark (9%), the Federal Republic of Germany (7%), and Norway (7%). The top five fish meal exporters accounted for 72% of total exports.

The list of top ten fish meal exporters in the 1982-1986 period also included the countries of Japan, Iceland, Ecuador, Thailand and the U.S.A. These producers respectively exported 5%,

4%, 4%, 4%, and 1% of fish meal products for a total of 18%. In total, the top ten fish meal exporters accounted for 92% of world exports. Canada exported slightly less than 1% of world-wide exports in the 1982-1986 period.

3.3.2 Analysis

There are some notable trends in the share of exports enjoyed by major producing countries over the period 1977 to 1986. Over this period Chile emerged as the dominant exporter, increasing its share of exports from 10% in 1977 to 33% in 1986. The top four exporters remained unchanged in 1987.

In 1977, Norway and Peru shared the position of the dominant exporter of fish meal. Peru's relative share of world exports remained fairly stable at 21% between 1977 and 1986, but its production increased steadily from 442,000 MT to 679,000 MT. Production increased to 730,000 MT in 1987 and should increase again in 1988 due to the large production gain. Norway's share of world exports fell from roughly 23% in 1977 to under 3% in 1987.

Less significant but noteworthy changes in export shares occurred for Denmark, the Federal Republic of Germany and Iceland. Denmark's share of world exports dropped from about 13% in 1977 to 7% in 1986 and 1987. West Germany's share rose from about 3% to 7% over the 1977 to 1987 period. Iceland's share of world exports fell steadily from a high of 9.5% in 1978 to about 2% in 1983 but rebounded to 5% by 1987.

3.4 Imports

3.4.1 Description

Fish meal imports by major importing country are shown in Exhibit 4. See pages I-9 and I-10 in Appendix I for a complete profile of world imports over the period 1977-1986.

EXHIBIT 4

FISH MEAL IMPORTS

x 1,000 MT

1987 RANK	MAJOR IMPORTERS	1982-86	%	1986	%	1987#	%
	World total	2,759.1		3,242.7		3,165.0	
2	West Germany	383.2	14%	478.3	15%	400.0	13%
1	Taiwan	266.7	10%	332.0	10%	430.0	14%
3	UK	204.7	7%	236.9	7%	250.0	8%
4	China	128.8	5%	193.6	6%	230.0	7%
6	USA	123.0	4%	168.1	5%	180.0	6%
10	Sweden	116.1	4%	108.6	3%	80.0	3%
9	Yugoslavia	99.0	4%	114.3	4%	95.0	3%
5	Japan	88.6	3%	161.5	5%	210.0	7%
8	Italy	84.9	3%	101.8	3%	100.0	3%
7	Netherlands	75.9	3%	115.9	4%	118.0	4%
	subtotal:	1,570.7	57%	2,011.0	62%	2,093.0	66%
	Canada	3.6	0.1%	3.0	0.1%	4.3	0.1%

1987 numbers are estimates based on FAO and USDA data.

Imports were more widely dispersed among countries than either production or exports, reflecting the wide dispersion in consumption shown previously. The top five importing countries accounted for 40% of world-wide imports from 1982 to 1986 while the top ten countries accounted for 57%.

West Germany imported the most fish meal of any country over the 1982 to 1986 period, having a 14% share of total imports. This share decreased by 2% in 1987 when the country imported 16% less meal than 1986. This high volume leads to the Hamburg fish meal price being the market indicator most often quoted. Taiwan was the second largest importer over the 1982-86 period with 10% of world imports. Taiwan moved to the number one position in 1987, with 14% of total imports.

The United Kingdom (7%) and China (5%) were the next leading importers of fish meal during the 1982-86 period. The U.S.A., Sweden and Yugoslavia all had a 4% share of imports. Japan, Italy and the Netherlands rounded out the top ten fish meal importers with 3% each. Canada accounted for only about 1/10 of 1% of fish meal imports over the 1982-1986 period.

The ranking changed greatly by 1987. Japan increased its share of world imports from 3% to 7%; both China and the US increased their respective shares by 2%.

3.4.2 Analysis

Shares of world imports over the 1977 to 1986 period remained quite stable. Taiwan's share of fish meal imports rose dramatically from 4% in 1977 to 13% in 1987. This is due to their large investment in shrimp farming. China's share of imports has risen steadily since 1981 when this country imported 0.7% of all fish meal products. By 1987 China accounted for 7% of total world imports. The United States increased its import share from 2.6% in

1977 to about 6% in 1987. Japan's share of world imports of fish meal fell from about 8% in 1977 to less than 2% in 1982. By 1987, this share rebounded to 7%. The Soviet Union, which had negligible imports of fish meal up to 1984 had about a 3% share in 1986.

3.5 Prices

Fish meal prices vary according to many factors, the most important of which are: the protein content of the meal, point of origin, and point of destination. For simplicity, the analysis in this section will deal with a 65% protein fish meal, cif Hamburg, West Germany. The price quoted is on a per metric ton basis.

Fish meal prices can be presented and analyzed in current and constant dollars. This section will present both cases. All prices are quoted in United States dollars.

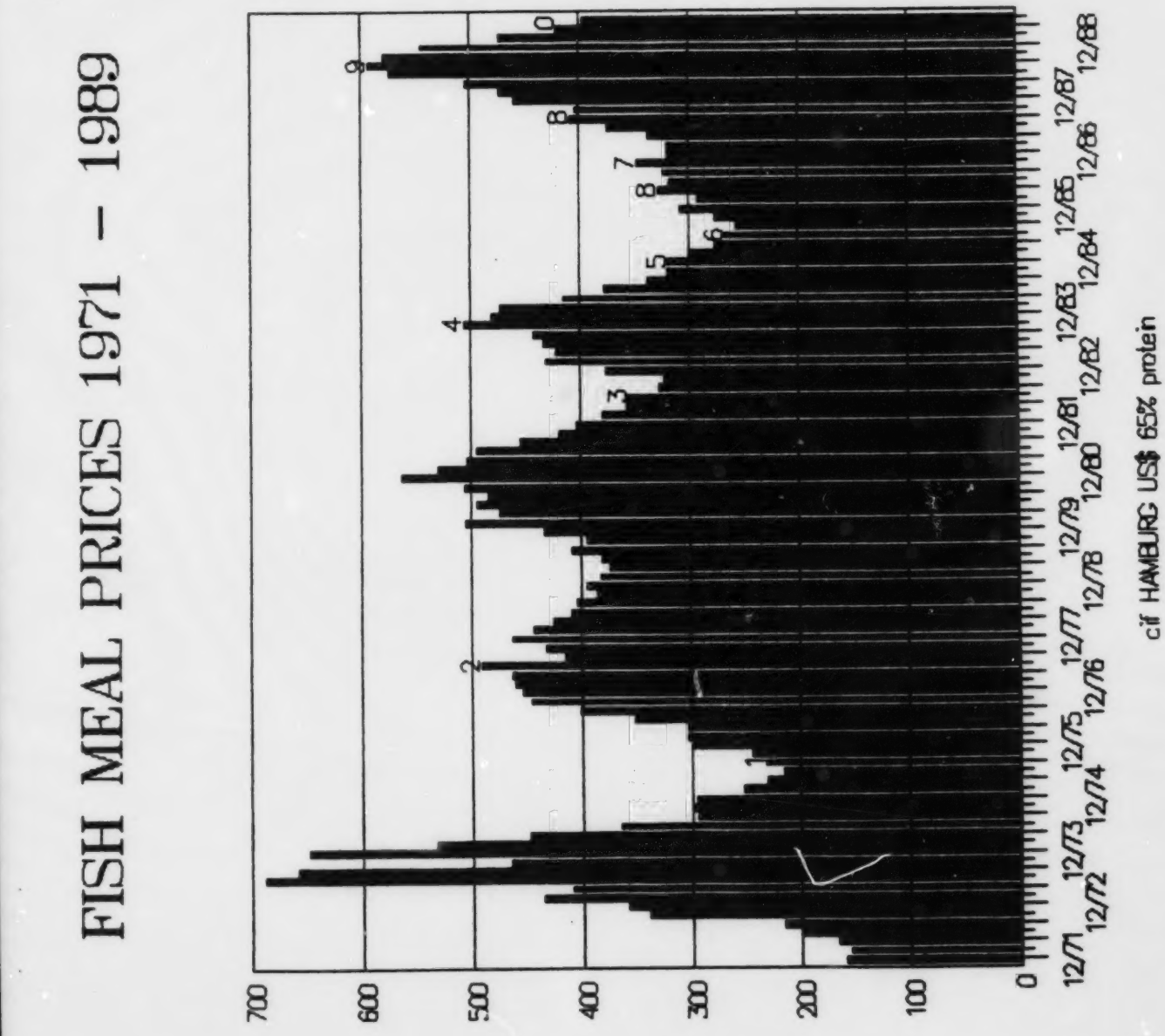
3.5.1 Description of Price Movements

Actual dollar prices

Fish meal prices reached five peaks since the early 1970's (see Exhibit 5). They peaked in mid-73, mid-1977, in late 1980, in late 1983 and in late 1988. The 1973 peak saw fish meal prices rise over $750 per metric tonne (MT). However, within a year, prices fell to under $220 per MT. The 1977 peak price was slightly over $500 per MT. Following the mid-1977 peak prices fell fairly consistently to about $365 by early 1979. Following this low point prices rose steadily for about one and one-half years, peaking at

EXHIBIT 5

Refer to page 28 for an explanation of the numbered points.



about $570 in late 1980. Fish meal prices declined from late 1980 to late 1982 when they bottomed out at about $320. Prices rose rapidly through 1983 peaking late in that year at just over $510.

A prolonged and severe price decline followed the late 1983 price peak. Prices fell steadily for almost two years to a low point of $255 in the summer of 1985. Three years of steady price increases followed the 1985 low point. Prices rose moderately through late 1985 and 1986 but accelerated through 1987 and 1988. By the summer of 1988 prices had reached a level of $609.

Refer to page 28 for a detailed explanation of these price changes.

The average price for fish meal, cif Hamburg, in 1988 was US$544 per MT. In comparison, the average price for fish meal, fob Halifax, N.S., in 1988 was US$528 per MT (60% protein). The average price for herring meal, fob Halifax, in 1988 was US$682 per MT (70% protein).

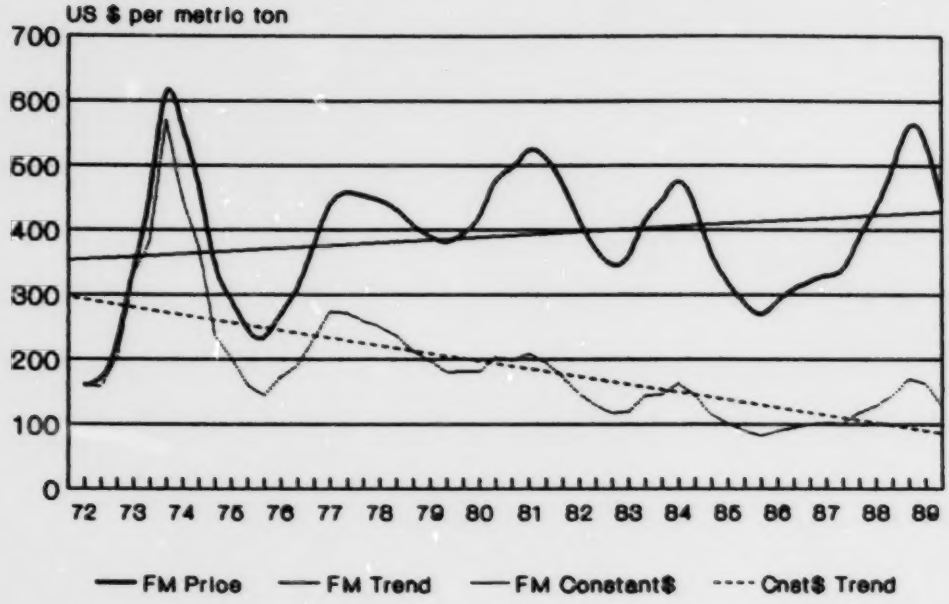
Constant dollar prices

Exhibit 6a shows the relationship between actual dollar prices and constant dollar prices for fish meal from the last third of 1971 to the first quarter of 1989. Constant dollar prices reflect actual dollar prices with the effects of inflation removed. The base year is 1971, where the Industrial Product Price Index equals 100.

The graph shows that the gap between the actual dollar and the constant dollar price of fish meal is widening. Although the

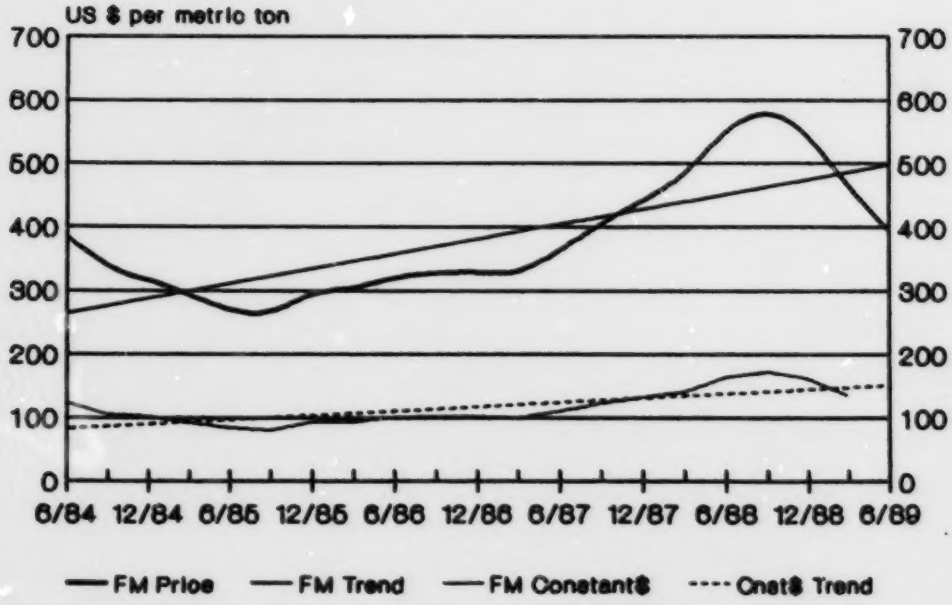
EXHIBITS 6A & 6B

FISH MEAL PRICES & TRENDS
1971 - 1989 4 month periods



INDUSTRIAL PRODUCT PRICE INDEX 1971=100

FISH MEAL PRICES & TRENDS
1984 - 1989 3 month periods



INDUSTRIAL PRODUCT PRICE INDEX 1971=100

actual dollar price trend is rising, the constant dollar trend line is declining for the period October, 1971 to March, 1989. Over the past five year period, from March, 1984 to March, 1989, the constant dollar trend is rising.

3.5.2 Relationship to Soybean Meal Production

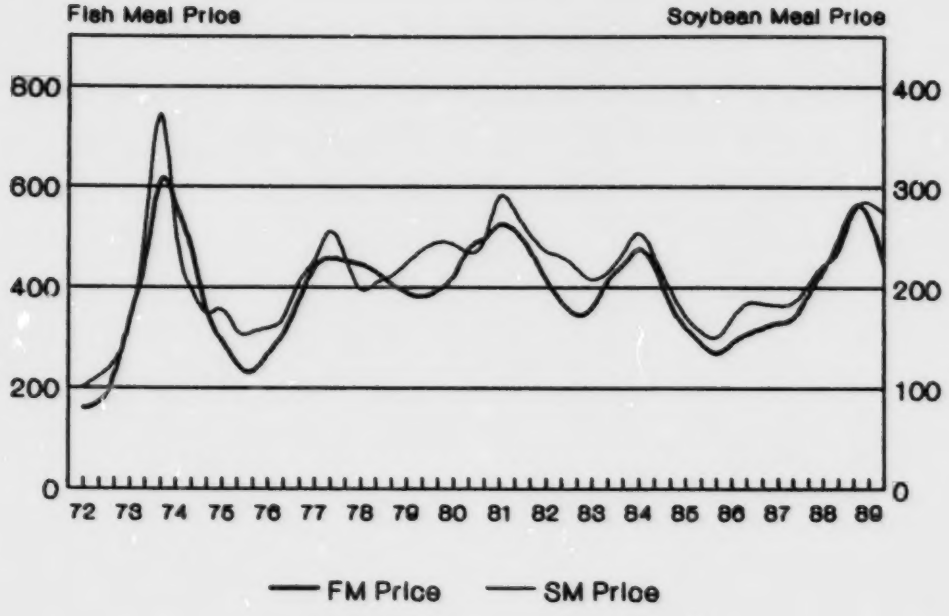
Soybean meal and fish meal are close substitutes. Both can be interchanged in animal feeds and pet food, depending on relative price levels. Fish meal has a higher protein content than soybean meal and is a good source of other nutrients in agricultural feed and pet foods. These attributes can be provided from other sources, however, if fish meal prices exceed acceptable levels relative to soybean meal. Feed producers use least-cost feed formulae to determine optimal meal usage.

The substitutability of fish meal and soybean meal in aquaculture feed is less than in other feeds. This is because fish meal contains much higher levels of lysine and sulphur amino acids than other meal products. These amino acids are essential for proper fish growth. Trout need a minimum of 30% fish meal in their feed while salmon need a minimum of 35%-40%. Warm water aquaculture species are less dependent on fish meal, with minimum requirements in the 10% range.

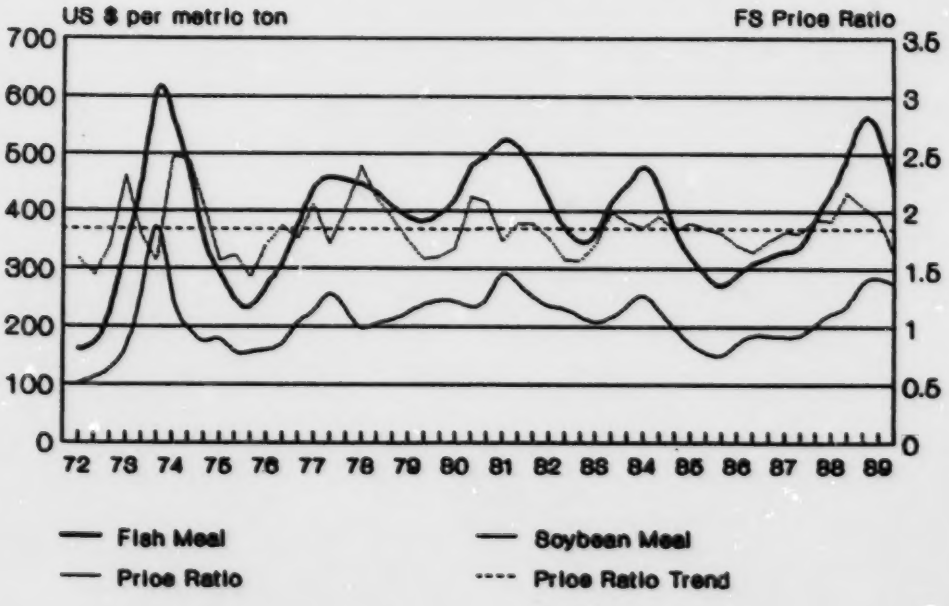
Exhibits 7a and 7b show historical prices for fish meal and soybean meal for the period, October, 1971 to March 1989. In Exhibit 7a, the scale on the fish meal axis (Y1) is set to be exactly twice that on the soybean meal axis (Y2). In Exhibit 7b,

EXHIBITS 7A & 7B

FISH MEAL vs. SOYBEAN MEAL PRICES
1971 - 1989 4 month periods



PRICE RATIO TREND
1971 - 1989 4 month periods



both meals are scaled on the Y1 axis, while the price ratio is scaled on the Y2 axis. The exhibits show that fish meal prices have maintained a fairly stable ratio of 1.85:1 to soybean meal prices over this period. For most of the 15 year period soybean meal prices were slightly more than 50% of fish meal prices, but they fell to slightly less than 50% by late 1987. The following table shows the average ratios over several periods.

Period	# Years	Ave. Ratio
April 1972 - March 1989	17 years	1.86
April 1979 - March 1989	10 years	1.85
April 1984 - March 1989	5 years	1.85
April 1988 - March 1989	1 year	1.93

This data shows that the fish meal-soybean meal price ratio is virtually constant in the long term. Variations occur when the rise (or fall) in fish meal prices does not proportionally equal the rise (or fall) in soybean prices. There will also be a time lag before the fish meal price change reflects the soybean meal price change.

Soybean meal makes up approximately 60% of all the oil meals consumed in the world. Fish meal makes up only about 5% of world consumption. Soybean meal is very uniform in quality and more stable in storage than fish meal, making it a preferred product to handle. It is substitutable in most feed applications except fish feed.

The close substitutability implies that soybean prices will exert a strong influence on fish meal prices. Indeed, many of the

cyclic changes in fish meal prices may be explained by occurrences in the soybean market. Since the United States produces, on average, 55% of the world soybean crop[5], conditions in this specific market greatly influence world prices. If the reader refers back to Exhibit 5, page 22, the influence of soybean production on fish meal prices can be shown by examining the numbers on that graph, which relate to the following points:

1. A huge 1974 soybean crop gives 27% rise in soybean meal production.
2. The 1976 US soybean crop is poor, but, imports of soybeans by the USSR and China are strong.
3. 8.5% increase in soybean production.
4. 12% drop in soybean production.
5. 10% increase in soybean production.
6. Large soybean harvest and small imports by the USSR and China.
7. 7% drop in world soybean production.
8. The USSR and China imported large volumes of soybeans.
9. 20% drop in US soybean crop and Asian countries import large volumes of soybeans.
10. Weak demand for soybeans by major importers and strong South American soybean harvest.

The stability of the 1.85:1 ratio implies that if soybean meal prices could be forecast, fish meal prices also could be estimated with some measure of accuracy. Reasons that could explain a change in the price ratio warrant careful analysis since they would decrease the reliability of soybean prices as a predictor of fish meal prices. The most obvious factor that could lead to a change in the price ratio is the increase in aquaculture production world-wide due to the relatively low level of substitutability by soybean

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[5] The 1985-87 U.S. average was 55% of total world production. The 1979-81 average was 64%.

meal in aquaculture feed.

Fish meal is substituted by vegetable meals if fish meal prices are considered too high. The extra food value derived from fish meal is considered a luxury that can be replaced. The essential amino acids provided by fish meal can be replaced with synthetic proteins.

3.5.3 Relationship to South American Production

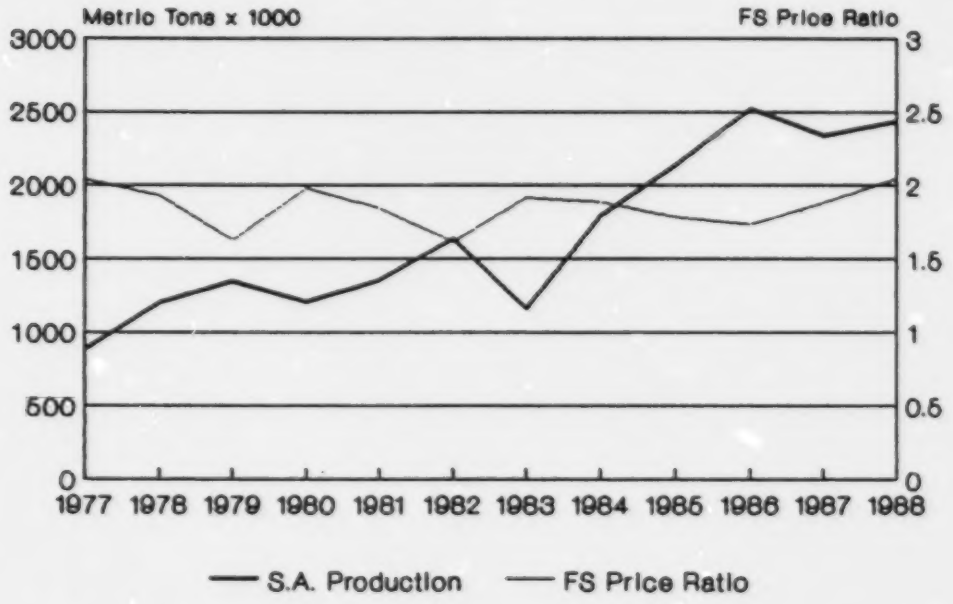
It was explained above that soybean meal prices exert a strong influence on fish meal prices. Fish meal prices will change to maintain a ratio of roughly 1.85:1 to soybean meal prices. It also was demonstrated above that there has been some variation around this ratio. It appears that the level of fish meal production in South America is the most important factor causing variation around the 1.85:1 ratio. South America produces about one third of all world production, but is responsible for 50% of all world exports. When South American production is low, fish meal prices tend to increase above the 1.85:1 level, while high South American production induces the opposite response.

This hypothesis receives some support from an examination of Exhibit 8, which shows the relationship between South American production and the fish meal-soybean meal (FS) price ratio from 1977 to 1988. The FS price ratio is averaged over 12 month periods and the lows and highs are somewhat mitigated (see Exhibit 7b, page 26 for monthly details).

South American production has increased steadily, except in

EXHIBIT 8

SOUTH AMERICAN FISH MEAL PRODUCTION vs. FISH MEAL-SOYBEAN MEAL PRICE RATIO



1983, over this time period. With each surge in production the FS price ratio dips below the long term 1.85:1 average. And when production drops the FS price ratio jumps up to 2:1.

Despite the high 1988 production level, the FS price ratio continued to climb in 1988 and only dropped below 2:1 late in the year. The downward trend accelerated in early 1989, dropping below 1.7:1 by March. The breakdown in the inverse relationship between the price ratio and South American production in 1988 is likely due to the disastrous U.S. soybean crop, which dropped 20% due to drought conditions.

3.5.4 Summary of Price Performance

The examination of constant dollar prices for fish meal over the 1970's and 1980's reveals that a downward price trend has occurred (see Exhibit 6a, page 24). For most of the 1980's the constant dollar price has been below the 1971 level. Exhibit 6b shows that the constant dollar price trend has been increasing over the past five years. The constant dollar price in late 1988 was just above the late-1971 level, but this was due to the peak price levels caused by the 1988 US soybean crop failure. The constant dollar price in March, 1989 was at the 1971 level.

The price performance of fish meal has been determined, to a large extent, by price changes in soybean meal. Fish meal prices have maintained a fairly constant ratio to soybean meal prices of 1.85:1. Variation in the FS price ratio appears to be caused by changes in the production of the South American countries of Chile

and Peru, which dominate fish meal export markets. Relatively high levels of production by these countries since 1984 has kept the ratio of fish meal to soybean meal prices below 2:1. A rise in the ratio above 2:1 in late 1987 and early 1988 could be associated with relatively low 1987 South American fish meal production. The disruption of the soybean meal market caused by the poor U.S. soybean crop in 1988 also may have contributed to the surge in the price ratio.

Increases in shrimp aquaculture in countries such as China and salmon aquaculture in countries such as Norway have affected export and import patterns significantly. Despite these events, the fish meal-soybean meal price ratio has remained below the 2:1 level for almost the entire 1980's decade.

4. ANALYSIS OF CURRENT MARKET SITUATION

4.1 Price Update

Fish meal prices have risen steadily since hitting a record low in July, 1985 (see Exhibit 5, page 22). The price peaked in July, 1988 at about US$610 (cif Hamburg, 65%). This was the highest price paid since December, 1973 for fish meal. There have only been three times since 1973 that the price has gone over $500. This was only the second time since September, 1981 that the constant dollar price exceeded the 1971 level (see Exhibit 6a, page 24). The actual price has dropped from this $610 high to about

$440 in March, 1989 and further to just under $400 in May, 1989.

4.2 Soybean Demand and Production

The recent surge in prices for fish meal was caused by several factors. The major factor was that drought conditions in the US reduced the 1988 U.S. soybean crop by 20%, compared to 1987 production. The US produces 55% of the world crop on average. This fell to 45% in 1988. Production was also down in China by 11%. However, South American production, which constitutes 25% of world production on average, was up by 17% over 1987. Total world production dropped by 6.3% overall.

Soybean meal constitutes approximately 60% of the world protein meal market, as compared to a 5% share by fish meal. Fish meal prices follow soybean meal prices very closely. Fish meal can be substituted by soybean meal (and other vegetable meals) in many feed applications. Feed manufacturers prefer fish meal, but only when fish meal prices exceed soybean meal prices by a ratio less than 1.85:1.

The expectation of a large shortfall in the US soybean crop pushed prices for all protein meal sources up considerably. As well, strong demand by China and the USSR up to mid-year gave support to high prices. Therefore, fish meal prices escalated to a point well beyond the 1.85:1 price ratio to about 2.2:1 in the first quarter of 1988. The price ratio fell in March, 1989 to just under 1.7:1 and declined further to about 1.5:1 in May, 1989.

The fall in the price of fish meal is directly associated with

declining soybean meal prices. Over the period in which fish meal prices declined from about $600 per tonne to under $400, soybean meal prices fell from just over $300 per tonne to $260. Fish meal prices fell proportionately more than soybean meal prices over this period. Exceptionally strong catches of pelagics in Peru is the likely explanation for the fall in the fish meal to soybean meal price ratio.

The immediate outlook for fish meal prices is for little or no increase. The latest information of soybean meal markets shows that soybean futures prices are declining due to predictions of abundant crops in the United States. The exceptionally low ratio of fish meal to soybean meal prices would indicate that fish meal prices may not suffer a large decline.

4.3 Fish Meal Supply: South America

The demand for domestic fish meal is dependent upon the supply of soybean meal as well as the supply of other fish meals. The major suppliers of fish meal to North America are Peru and Chile. The primary South American fish species used for meal are sardine and anchovy. Lesser species are jurel, horse mackerel and hake. Total South American meal production is over 40 times Canadian production and six times US production. Canada began importing fish meal from Chile in 1984.

A secondary cause for high fish meal prices in 1988 was uncertainty in the market concerning South American fish meal

production. The warm 'El Nino' current[6] off the coast of Chile in January-February 1987 reduced South American fish meal production by 24% in that year. Chilean stocks recovered slowly from the poor 1987 season, causing great concern in the market. Fishermens' strikes in the spring of 1988 added further uncertainty. However, fish meal production in Peru and Chile rebounded to near record levels by year-end, 1988.

The other major source of fish meal for Canada is the United States. Its major industrial fish is menhaden, which has a lower protein level (60%) than herring meal (70-74%). The 1988 menhaden catch dropped 24% from the previous year, reducing available US fish meal stocks.

4.4 Fish Meal Demand: Aquaculture

Another contributing factor to the strong fish meal prices is the growing demand for fish meal from aquaculture industries, world-wide. The tremendous growth in aquaculture in the past five years has increased the demand for fish meal, which is the primary protein component in fish feed. Production figures in 1986 for salmon show approximately 70,000 MT were farmed around the world. A recent paper co-authored by David Egan and Peter Leitz, Vancouver, predicts world production of farmed salmon will increase to 172,000 MT by 1990 and to 350,000 by the year 2000. It could be

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[6] See John Vondruska's paper: Postwar Production, Consumption, and Prices of Fish Meal, Resource Management and Environmental Uncertainty, John Wiley & Sons, Inc., 1979, Chapter 10, pp.299-304, for an excellent discussion on the El Nino current.

expected that both the fish meal price and its ratio to soybean meal would increase with increased aquaculture production. The large quantities of fish meal used in aquaculture feed and the low level of substitutability with soybean meal should induce this increase. Data on fish meal prices and the price ratio provide no evidence to support this hypothesis.

5. PROJECTION OF PRICES

Three factors will determine the future prices of fish meal. These are the supply of fish meal, the demand for fish meal and the price of substitutes. Fish meal supplies have averaged about 6.3 million tonnes annually since 1984. These supplies are subject to considerable variability caused by fluctuations in fish abundance, particularly the oily fish species of South America. There does not appear to be much room for growth in the supply of fish dedicated to fish meal unless prices stay at very high levels. The exception to this generalization is Peru where large stocks of pelagics may be available for the fish meal industry.

> "Estimates of the amount of fish available in Peruvian waters are as high as 15 million tons of anchovy, pilchard, mackerel and horse mackerel." (Fishing News International, March 1989)

For the purposes of this report, it will be assumed that supplies of fish meal will remain constant.

The price of soybean meal is a significant determinant of the price of fish meal. Exhibit 7b, page 26 shows that the ratio of

fish meal to soybean meal has averaged 1.85:1 over the past five years. In fact, this ratio has remained constant over the past twenty years. If it was possible to predict the price for soybean meal, the price of fish meal could be projected with some confidence by multiplying the soybean meal price by 1.85. This technique provides a "first-cut" at predicting fish meal prices. The estimated prices could be revised to account for factors that may cause the historical price ratio between the two meals to change.

Soybean meal prices also are determined by the supply of and demand for soybean meal and the price of substitutes. The supply of soybean meal is notoriously hard to predict because it is determined largely by weather conditions in such important producing areas as the United States and South America which account for 75-80% of the world soybean crop. Meteorological events such as the "greenhouse effect" and depletion of the ozone layer certainly will have a major impact on soybean meal production.

A warming climate will result in drought in some areas while extending growing areas in more northerly regions. The extent of climate changes and the impact of these changes of soybean meal production are too uncertain to predict.

Two additional factors that will influence the supply of oilmeals are international policies regarding agricultural production and agricultural reform in important countries such as the U.S.S.R. and China.

Trade liberalization resulting in the reduction of agricultural subsides could have a positive impact on oilmeal prices as is illustrated by the following quote from a publication entitled, Oilworld, 1958 - 2007.

> "Contributing to our expectations of a new phase with higher price levels than we experienced during 1986, 1987 and early 1988 is the assumption of agricultural subsides in the EEC, the US and elsewhere as a result of the Uruguay Round of GATT. The prospective liberalization, i.e. reduction of oilseed protection, in the US and the EEC as well as in South America cannot but eliminate the high-cost and uneconomic producers and raise prices for the remaining producers in order to stimulate them to produce more" (p. 42).

Political and agricultural reforms, now in full progress in the U.S.S.R. and China, can be expected to increase the production of oilseeds significantly. The dampening impact of these events on prices likely will be offset by increased animal production in these countries. Oilseed analysts predict that the net effect of agricultural reforms will be an increased demand for oilmeals.

Demand for soybean meal is dependent to a significant degree on animal production world-wide. The availability and price of substitute oil meals also influences prices that can be anticipated for soybean meal production.

Overall, world-wide demand for oilmeals is expected to grow significantly over the next 15 to 20 years.

> "Thus the output of livestock products of China and 'rest of world' is expected to reach 197.5 mill. T. annually in 2003-2007 or as much as 86% more than the average of 1983-1987. As against this, the total output of livestock products of West Europe, the U.S.S.R., North America and Argentina is expected to increase only by 19% to 153.6 mill. T." (Oilworld, 1958-2007, p. 28)

Caution is required in linking growth in livestock production

to growth in oilmeal demand. As noted in Oilworld:

> "The development of livestock production is, of course, a very important factor determining the demand for oilmeals. But it is not the only one. The intensity of feeding, i.e. the protein content of feeds, is another very important determinant." (p. 28)

High grain prices, particularly in the EEC, increased the use of oilmeal to supply protein over the 1970's and 1980's. Usage of oilmeals per tonne of livestock production has peaked in EEC countries. The increasing substitution of synthetic amino acids for vegetable protein may contribute to a decline in the per tonne use of oilmeals. Increases in the per tonne usage of oilmeals in countries such as the U.S.S.R. and China will, however, lead to an overall increase in the per tonne usage of oilmeals by some 20% over the next 15 to 20 years.

The demand and supply factors noted above have resulted in a prediction by Oilworld that prices for oilmeals, including soybean meal, will rise over the next 15 to 20 years. Despite this prediction, the authors of this paper will conservatively assume that real soybean meal prices will remain constant. There are two main reasons for this. First, the factors contributing to expectations of higher prices are long-term and subject to a high degree of uncertainty. Climate changes and agricultural policies of key countries are notable examples. Second, there is no way to quantify the prospective growth in prices from supply and demand forces.

An examination of past trends in soybean meal prices shows that constant dollar prices have declined fairly steeply since late

1971 (see Exhibit 9a). Over the past ten years the downward trend has been more gradual. Over the past five years constant dollar prices have risen slightly (see Exhibit 9b). In the face of these trends, the assumption that constant dollar soybean meal prices will remain at the average level experienced over the last five years ($62.10 per MT) appears realistic. The long term 'first-cut' projection for fish meal prices is that they will maintain a 1.85:1 ratio to the 1984-89 average constant dollar soybean meal price calculated above. The equivalent actual price for fish meal is US$400 per MT, cif Hamburg, in 1988 dollars.

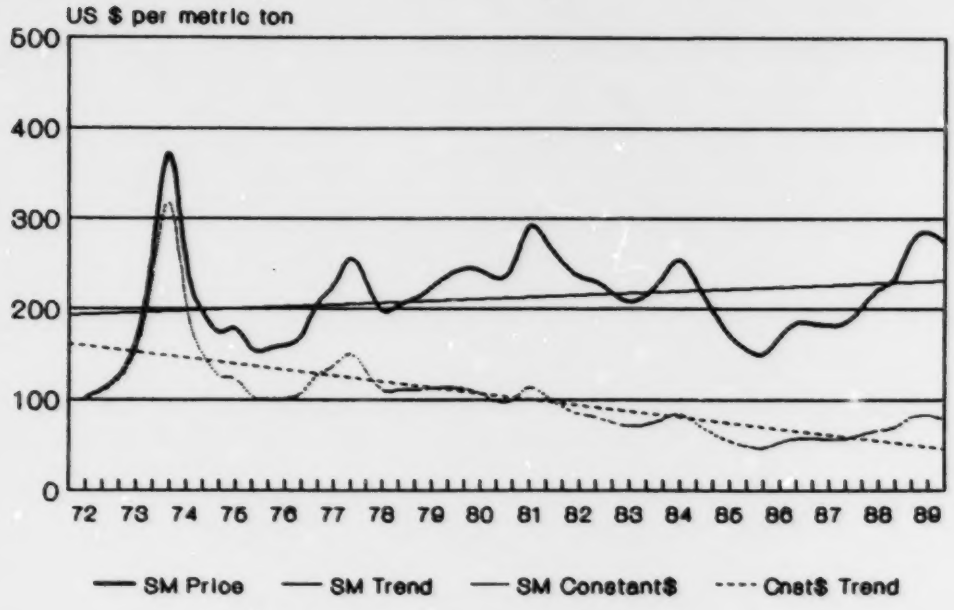
Aquaculture is an important user of fishmeal, consuming about 600,000 tonnes of the 6 million tonne production of fishmeal. The relative importance of aquaculture is illustrated by the following quote from the March, 1989 issue of Fishing News International.

> "Poultry producers remain the biggest customer of the fish meal industry, buying some 60 per cent of production. The pig industry takes 20 to 25 per cent, while the growing fish farming industry consumes ten per cent. Enterprises such as mink farms and feeding pets consume the remaining five per cent."

The growth in aquaculture has been spectacular on a worldwide scale in the last couple of decades. In the west, farmed salmon production has led the surge in aquaculture growth. World production has jumped from negligible levels a decade ago to the 200,000 ton level estimated by the International Salmon Growers' Association for 1989. The growth in aquaculture production in the Far East, combined with increased livestock production, has stimulated fish meal demand.

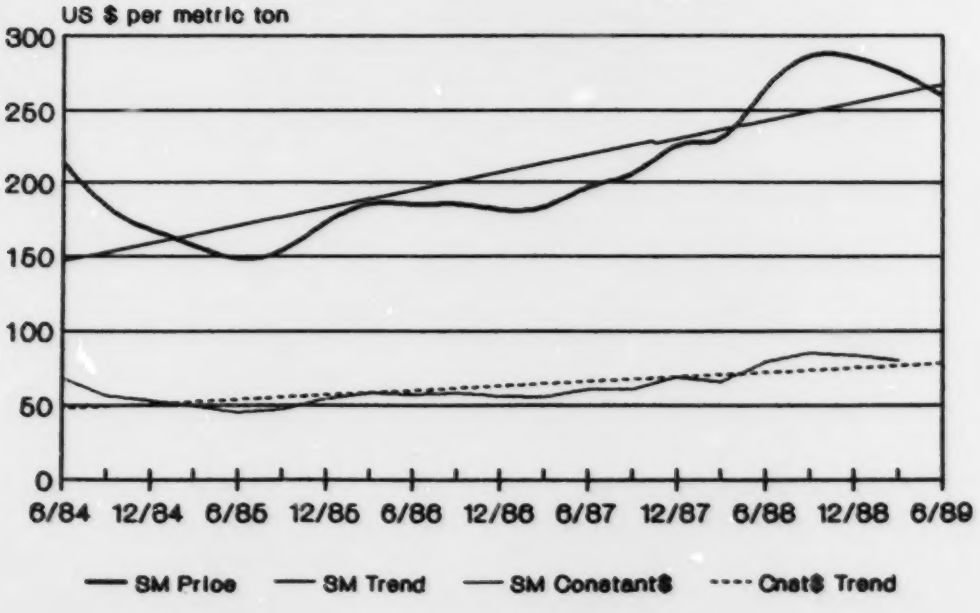
EXHIBITS 9A & 9B

SOYBEAN MEAL PRICES & TRENDS
1971 - 1989 4 month periods



INDUSTRIAL PRODUCT PRICE INDEX 1971=100

SOYBEAN MEAL PRICES & TRENDS
1984 - 1989 3 month periods



INDUSTRIAL PRODUCT PRICE INDEX 1971=100

The situation in China was summed up by Oilworld as follows:

> "Aquaculture has been one of the leading growth industries in the country since 1979. China has been so successful in improving its fish farming techniques that production has risen 150% over the past 10 years and will amount to more than 10 mill. T." (Jan/Dec 1988., p. 20)

The implication of the growth in aquaculture industries is illustrated by the following quote from a recent issue of Fishing News International.

> "By the mid-1990's more than 1,000,000 tonnes of fish meal will go towards the diets of finfish and shellfish. The International Association of Fishmeal Manufacturers' figures for 1988 suggest that more than 600,000 mt of meal was sold to the aquatic farming industry."

Note that while a 400,000 tonne rise in demand for fish meal emanating from the aquaculture industry will tend to push prices up, the increase represents less than 7% of current fishmeal consumption. The impact of the increased demand could be swamped by negative market forces in industries, such as chicken or pig farming, that are much larger users of meal.

The rapid growth in world aquaculture is projected to continue into the future. The growth in the aquaculture industry, combined with the limited degree of substitutability of vegetable meals for fish meal in aquaculture, implies that the 1.85:1 ratio of fish meal to soybean meal may increase somewhat in the future. The assumption of an increase in the fish meal price relative to the soybean meal price may be overly optimistic. Advances in feed technology may increase the ability of feed manufacturers to substitute vegetable meals and synthetic chemicals for fish meal. It was noted above that an unidentified growth factor in fishmeal

increases animal and fish growth. This fact has led nutritionists to include fish meal in animal feed diets even when computer models that determine least-cost feed formulation indicate that it should not be included. If methods are devised to provide these nutrients artificially, fish meal demand may decrease appreciably.

The expansion of world aquaculture industries may introduce a premium for fish meal prices. However, price trends to date do not indicate that the aquaculture industry has affected trends in fish meal prices. This is probably due to the size of the agricultural sector's demand for fish meal compared to the aquaculture sectors' demand, which is much smaller. An optimistic case could be introduced where the fish meal/soybean meal price ratio rose to 2:1. In this case the long term fish meal price would be US$432 per MT, cif Hamburg, in 1988 dollars.

A crucial finding for this study is that the increase in the demand for fish meal will occur primarily for high quality meals. The aquaculture industry requires very high quality meals with a precise nutrient composition. Increasing demand for lean meat and specialty meat products reinforces the emphasis on quality.

The outlook for high quality, specialized fish meal is illustrated in the following quotes.

> "Increasing demand from Japan, Taiwan and China - and the growth in value added products - is making the six million ton a year fish meal industry more buoyant. Production is rising and plants are re-equipping to produce special products.
>
> "Added value fish meal products are now providing extra revenue to countries geared up for production. Both Norway and Denmark are well-placed in this trade which supplies specialized feeds to the salmon farming industry

and to pig farmers.

"Early wean piglets switching to special fish meals enable expensive milk products in the diet to be reduced and farmers are, therefore, willing to pay a premium of up to 50 per cent for these specialized feeds." (Fishing News International, March 1989)

6. REVIEW OF CANADIAN INDUSTRY

6.1 Statistical Review

6.1.1 Production, imports, exports, and consumption

Production of fish meal in Canada has remained relatively stable over the past ten years at approximately 66,000 MT (see Appendix I). Canadian production represented one percent of world production in 1987. About 10% of Canadian meal originates on the Pacific coast and 90% from the Atlantic coast.

Groundfish accounts for about 80% of all fish meals produced in an average year; 95% of this production comes from Atlantic Canada and about 5% from B.C. Pelagic meal accounts for about 20% of total Canadian fish meal production. Approximately 1/3 is produced in B.C. and 2/3 in Atlantic Canada.

Canada began importing fish meal in substantial quantities from the United States in 1981, and from Chile in 1984. In 1987 imports totalled 10% of total consumption.

Canada's exports have averaged approximately 38% of total production over the 1982-1987 period. Herring meal made up about 1/4 of total exports and groundfish meal 3/4. The major market is the United States; smaller markets are the United Kingdom and

Taiwan.

Total domestic consumption of fish meal averaged about 70% of production over the 1982-1987 period.

6.1.2 Prices

The average price of groundfish meal (60% protein, fob Dartmouth, Nova Scotia) in 1988 was $650 Cdn. ($528 US[7]). Herring meal (74% protein, fob Dartmouth, Nova Scotia) sold at an average price of $840 Cdn. ($682 US). Exhibit 10 shows the price relationship between Canadian groundfish meal and 64% protein meal, cif Hamburg, Germany over the past 18 months. These prices are not directly comparable for consumption pricing purposes, but, the relative changes should be noted. A lag time of about three months is evident before the Canadian price reflects changes in the larger European marketplace.

The 1988 average price for herring meal exceeded groundfish meal by $154 US per metric tonne (MT). This large price difference may be considered temporary and unusual, reflecting the extremes of the market in times of excessive demand. Current price differences between groundfish and herring meals are in the $45 US to $117 US range.

The average price for groundfish meal (60% protein, fob Dartmouth, Nova Scotia) in April, 1989 was $576 Cdn. ($482 US). May prices have declined to the $480-$495 Cdn. range. Herring meal

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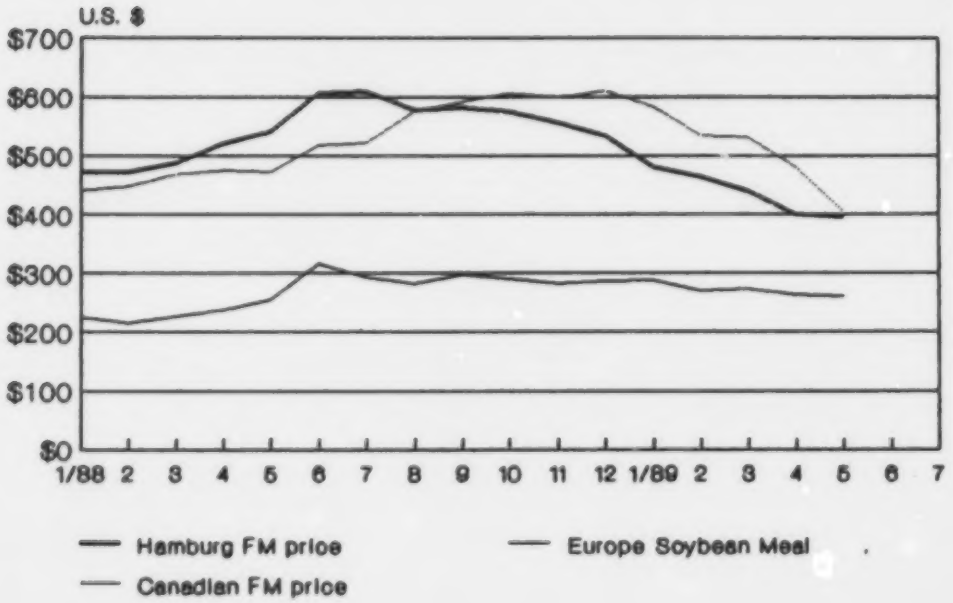
[7] An exchange rate of .8124 (Canadian dollar in U.S. funds) is used for the 1988 average prices. The Bank of Canada Review is the source for this figure.

EUROPEAN FM PRICE, clf Hamburg 65%
CANADIAN FM PRICE, fob Dartmouth 60%



prices are steady at $630 Cdn. ($527 US). Customers in Montreal would add about $40 per MT for shipping costs and B.C. customers would add about $145 for shipping.

6.2 Industry Update

6.2.1 Plants

There are 43 plants producing fish meal in the Atlantic provinces. The breakdown by province is:

New Brunswick	5
Newfoundland	19
Nova Scotia	15
PEI	2
Quebec	2
	43

Refer to Appendix II for maps showing the locations of existing facilities.

The number of plants producing each year is variable, depending on fish harvests and the price of meals. Many meal plants were built in the 1960's to accommodate the demand for fish meal at that time. Overfishing led to a government restriction on the harvest of fish for reduction purposes. This led to a decline in fish meal production through the 1970's and 1980's, making many of the existing plants uneconomical. Further rationalization of fish meal plants due to declining catches and low fish meal prices has also affected production. Only one plant has been built in Nova Scotia since 1981; by Lawrence Sweeney Fisheries in Lower East Pubnico.

The size of the 43 meal plants in Atlantic Canada range from a

rated input capacity of 5 MT per 24 hours to 750 MT per 24 hours.[8] An average size capacity would be 200 MT per 24 hours. The average plant in Nova Scotia is smaller, around 175 MT per 24 hours. The average plant in New Brunswick and Newfoundland is larger, about 300 MT and 230 MT per 24 hours, respectively. The majority of meal plants, perhaps as high as 95%, are attached to fish processing plants. The only stand-alone plants are one in P.E.I. and a few in Nova Scotia.

The typical plant in Eastern Canada was built with used parts and equipment. Upgrading occurs in years of profitable earnings. The typical plant is not state-of-the-art. To replace would cost $3-4 million dollars if new equipment were purchased.

The age and condition of the processing equipment will determine the product yield. Older plants which do not recycle the stickwater may receive only 12% fish meal from total raw material. A modern plant may receive up to 22% yield from similar raw material.

6.2.2 Production

Many plants buy offal from other fish processing operations to supplement production. This occurs for most meal plants during the seasonal herring roe and capelin roe fisheries. A 1985 report on the Atlantic fish meal industry suggested that production

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[8] Fish Oil Production and Potential in Atlantic Canada, James H. McClare and Associates Ltd., December 1986, Appendix A.

efficiency rates (based on an 8 hour day) are in the 50-55% range.[9] This was the primary feedback received from fish meal plant operators; there was over-capacity in the industry. Many plants operate only during seasonal fisheries, and only then do most plants operate 24 hours per day. The newly built L. Sweeney Fisheries meal plant has a capacity of approximately 500 MT per 24 hours. It is expected to operate only 3 to 4 months of the year and at full capacity only during the fall herring season.

Groundfish meal production is limited now due to a lack of raw material. Existing quotas provide enough offal for only a few meal plants to operate beyond a 3-4 month season. With the recent reduction of East coast groundfish quotas and smaller fleet catches, production will probably decrease in future years.

Further development in fish meal production will only be able to access the herring or capelin fisheries. There is a lot of competition for other species due to quota restrictions and the simple fact that any large fish plant that is supplied by its own boats now has an integrated meal plant. As a reduction fishery is not allowed by the Fisheries Act, the development of under-utilized species is not feasible now.

6.2.3 Products

There are many fish species used in the production of fish meal. Groundfish meal is produced from cod, flounder, haddock,

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[9] The Atlantic Fishmeal Industry, Commercial Analysis Division, Economic and Commercial Analysis Directorate, Department of Fisheries and Oceans, September 1985, page A-5, Appendix IV.

redfish, turbot and pollock. The groundfish are processed for human food with most of the flesh (fillets) stripped from the fish. This leaves the head, tail, guts, skin and bones to be used for meal. Groundfish meal is sometimes divided into white and brown meals. White meal is made from cod, flounder and haddock, while brown meal is made from redfish, turbot or pollock. Groundfish meal generally consists of 60-63% protein.

The major pelagic species used for fish meal are herring and capelin. These species are harvested for their roe, which is sold primarily in Japan. Usually, only the roe is stripped from the fish, leaving all the males and the flesh from the females to be used in meal production. As the flesh consists mainly of protein, these species give the highest percentage protein meal; approximately 74% protein.

Other meals are produced from shellfish and tuna. West coast meal plants use salmon, halibut and dogfish as raw material. The volumes produced from these sources are minimal.

6.2.4 Markets

The market niches presently being fulfilled by Canadian meal producers are: herring meal for aquaculture, white meal for Far East aquaculture, and the rest appears to be used in agricultural feed. A big problem in defining end users is that producers often sell to brokers who then sell to users; the producers have no idea who buys and the users have no idea who produced it.

On average, 38% of Canadian meal production (20,000 MT) is

exported; of which 75% is groundfish meal. B.C. imported 2,200 MT of Atlantic herring meal in 1986; or 55% of its requirements for aquaculture feed production.[10] The majority of Atlantic herring meal is used for aquaculture feed production on the east coast.

The demand for fish meal in Canada comes from both agriculture and aquaculture feed producers. Present supply meets demand except for west coast fish feed producers. Although the present supply of herring meal is adequate on the east coast, some fish feed producers believe that present production levels will be insufficient by 1992.

British Columbia is experiencing a shortage of domestic fish meal supply now, according to an industry source. The extra demand is being filled by South American producers. This is in part due to the low quality standards followed by most east coast meal producers. The west coast fish feed producers believe that east coast meal is not up to the high standards required for salmon feed.

If the world supply of fish meal becomes problematic, and prices rise, the fish meal now purchased for animal and agricultural feeds will probably be substituted by soybean or other meals. These industries will rationalize feed production to meet cost formulations. The aquaculture industry will pay higher prices for fish meal because it is less substitutable in fish feed.

Ingrid Jangaard stated that NatSea produced about 12,000 MT of

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[10] Strategy to Access Critical Raw Materials for Fish Feed-B.C. Salmon Farming Industry, The DPA Group Inc., Vancouver, B.C., 1988, p.4-7.

fish meal last year. Some of their plants run year round and some are seasonal. She said that Fisheries Products International (FPI) probably produced an equivalent amount of meal. Of the 12,000 MT, only about 800 MT (7%) was herring meal; the rest was mixed and white meal. She said that all of their herring meal is used in aquaculture, with most going to BC due to lack of demand locally. Approximately 64% of the groundfish meal went to agricultural use in Canada and 24% went to the Far East (high quality white meal to be used in eel and shrimp aquaculture).

Ms. Jangaard said that in world markets, both FPI and NatSea are very small players. NatSea ships by the container load, but some Asian buyers were looking for boat loads this past year; single order quantities well in excess of NatSea's annual production. She said that since NatSea couldn't compete on a large volume basis they would try to specialize in producing high quality products such as white meal. She said that there is currently no problem selling this particular product.

6.3 Production and Costs

6.3.1 The Reduction Process

In simplified form, a fish meal plant looks like this: (PROCESSES are capitalized and products are underlined.)

offal -> COOKER -> PRESSER = 1) presscake -> DRYER -> GRINDER = meal
= 2) liquids -SEPARATOR/DECANTER = 1) oil
= 2) stickwater

The cooker, presser and separator/decanter technologies have not changed since the 1960's. Used equipment is readily available in Europe (Sweeney Fisheries bought the equipment for their new plant in Norway).

The new technology in fish meal processing applies mainly to the drying process, which is very expensive equipment. There are three methods used to dry fish meal; two are indirect: a vacuum-steam combination, and steam alone; and one is direct: open flame.

The direct, open flame method is known to cause damage to the meal, such as burning it and destroying the essential acids. A survey performed in 1984[11] showed that 16 of 30 fish meal plant in the Atlantic provinces used the direct flame dryer type in their plants. Only 5 of 14 Nova Scotian plants used direct flame, but, 8 of 11 used this dryer type in Newfoundland. The

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[11] Fish Meal Odour Control Survey for Atlantic Canada, L. Atwell, Environment Canada, June 1984. A response of 75% was obtained to the questionnaire.

benefits of this dryer type are low purchase and operating costs and high throughput.

Optimum quality meal is supposedly only produced by the steam-dried methods. The vacuum drying method is a new development in Europe. It allows the meal to be dried at a lower temperature than regular steam drying, thus minimizing damage to the meal. The predominant method used in newer Canadian plants is regular steam drying, due to its lower cost than vacuum-steam drying and higher quality control than open flame.

National Sea Products, Halifax, use the steam drying method in all of their Maritime plants. However, many plants on the east coast use the open flame process, which is the cheapest method. One east coast fish feed producer said that his plant buys steam-dried meal only. Only if steam-dried meal was not available would he buy flame-dried meal.

The new plant in Nova Scotia, built by Sweeney Fisheries, uses a vacuum-steam dryer in its plant. This equipment lowers the temperature at which the meal is dried and allows for the vapors from the meal to be redirected from straight discharge to be used to heat the boilers or in the evaporation process. The main drawback of this technology is that throughput is reduced and processing costs increase.

Fish meal plants are notorious for the odors resulting from the drying process and which are carried out by the steam. This is one of the primary barriers to developing or expanding a meal plant. This problem has been partially solved by re-using the

steam, but few plants have this technology. There is still a problem when shutting down the boilers at closing time because the steam cannot be rerouted and must be exhausted.

Another problem is from 'stickwater' effluent. Meal is first cooked and then pressed dry. The liquid is then separated into oil and a leftover called stickwater. This is often piped back into the sea, but this is frowned upon as the stickwater needs copious amounts of oxygen from the seawater to decompose. The Sweeney plant evaporates the stickwater and puts the solids back into the presscake, thus adding to their meal and eliminating wastage. Again, few plants in Atlantic Canada are using this technology.

Therefore, the final product yield to be expected using mainly herring as the raw material is a maximum of 22%; combining the ash and protein levels. The meal plants using older equipment and processes obtain yields of about 14% overall. A spokesperson for NatSea said that yields at their plants were consistently in the 19-20% range; primarily due to adding the stickwater back to the meal.

6.3.2 Cost of Production

A 1982 study[12] prepared for the Nova Scotia Department of Fisheries determined that a fish meal plant with an input capacity of 100 MT per day would cost approximately $3.7 million

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[12] Fish Waste Processing in Nova Scotia, DPA Consulting Ltd. et al, May 1982, p.68.

(in 1989$). This cost includes $2.2 million for equipment and $1.5 million for the building, storage, and various services required. Output from this size plant is estimated at 10 MT per day, 8 hours per day, 5 days per week, 50 weeks per year, or 2,500 MT per year.

Variable operating costs are estimated to be $300 per MT with free raw materials, and $345 per tonne when the raw material cost $.02 per lb.[13] The major variable costs, based on the $345 figure, are labour ($75/MT - 22%), fuel ($80/MT - 23%), and raw materials ($45/MT - 13%).

Fixed overhead (including taxes, depreciation, indirect labour) is set at 20% of equity, or $440,000. If this is applied on a per tonne basis ($175 per MT), the total cost per MT of fish meal product is between $475 per MT and $520 per MT.

The cost structure for this model plant is used to provide a rough estimate of the financial viability of a herring meal plant proposed for construction in May, 1989. A herring-meal-only operation is modelled in recognition of the severe shortage in groundfish supplies in Atlantic Canada that would result in minimal supplies of groundfish offal for fish meal processing. Note that the viability of the plant is extremely sensitive to the assumptions regarding scale and capacity utilization. Results from the calculations made here should be perused with this in mind.

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[13] These figures are composed from data provided by two fish meal plant operations.

Based on the consultants' knowledge of the herring roe fishery in the Atlantic provinces, it is assumed that a meal processing plant could operate for 30 days at 24 hours per day and 30 more days at 12 hours per day. In total, it could operate for 1,080 hours annually. This is the equivalent of 135 days of 8 hour shifts. At an output capacity of 10 MT per day, the plant would produce 1,350 MT of herring meal per year.

Variable costs per tonne would range between $300 and $345 depending on the cost of raw materials. It should be noted that to produce the volumes assumed here, a plant would have to pay at least the transportation costs for most of its raw material. This amounts to $.01 per lb. at a minimum. Fixed overhead costs would be about $325 per MT based on yearly production of 1350 MT. This figure is high due to the relatively low output of a herring plant with no access to groundfish supplies.

The total cost per tonne of producing herring meal would be between $625 and $670. This higher cost exceeds the May, 1989 herring meal price of $630 per MT. That is, if the meal producer had to pay for raw material, the plant would not be viable based on existing prices. Long-term price projections made in this report indicate that the May, 1989 herring meal price may be between 1% and 9% below the equilibrium prices. Depending on the impact of the aquaculture industry on meal prices, long-term prices for herring meal could then be between $635 and $685 per MT. These figures indicate that a plant of the scale and throughput noted above would be a marginal operation.

Sweeney Fisheries' new plant in East Pubnico was built under the assumption that it would only operate for 3-4 months and be profitable. The major source of supply is from the fall roe herring fishery (approx. 75-85%), with some herring and groundfish harvested before and after this time processed for bait, fillets, and meal. Part of the plant was bought used and part bought new, depending on the technology requirements. The plant cost about $5 million. It has an input capacity of about 500 MT/day (20 MT/hour). The size is necessary to maximize processing of the large landings of herring. The technology is necessary to optimize meal quality, product yield, and to satisfy environmental obstacles. 1988 was its first full year of production. The plant manager was unwilling to discuss details concerning actual construction costs and operating costs.

6.4 Capacity Considerations

6.4.1 Review of capacity and Utilization

The number of fish meal plants producing in each of the four Atlantic Provinces are shown in section 6.2 of the chapter. Unfortunately, it was not possible to collect and aggregate data on the capacity and production of these plants. The only information comparing capacity and production identified by the consultants was contained in a 1985 study carried out by the

Economic and Commercial Analysis Directorate of D.F.O., Ottawa.[14] This study showed that in 1985 fish meal production was about 60,000 tonnes, or 60% of capacity.

As noted above, 75% of fishmeal produced in Atlantic Canada is made from groundfish. Groundfish catches will be significantly lower in the foreseeable future than they have been in the past. The additional capacity to process groundfish into fishmeal is unlikely to occur. Pelagic fish meal processors that rely on groundfish to extend their processing season may have difficulty gaining access to this raw material.

Production of pelagic species, notably herring and capelin, into fishmeal is a more likely event due to the relative health of these stocks. The biggest barrier to the addition of capacity for pelagic species is that landings of these fish species are highly seasonal. Despite an apparent surplus of raw material availability, plants would have considerable difficulty accessing enough raw material to be viable. Analysis conducted for this report indicates that a minimum of two months production at full capacity is required to achieve viability.

The amount of production needed to be viable depends on prices received for fish meal products. Research completed in this report indicates that the high fish meal prices that prevailed in 1988 will not be sustained over the long-term.

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14 The Atlantic Fishmeal Industry, Commercial Analysis Division - Economic and Commercial Analysis Directorate Department of Fisheries and Oceans, September, 1985, Appendix IV, p. A-4.

Long-term price levels likely will be closer to the levels being experienced in May, 1989. The growth of the aquaculture industry may push this price up somewhat, but investigations indicate that the aquaculture induced push will be in the order of 10%.

The bright spot for the fish meal industry is in high quality, specialty feeds. Low-temperature, steamed fish meal processors are required to meet the nutritional requirements of these feeds.

6.4.2 Recommendations

1. The market analysis for fish meal prices shows that, while demand and prices for fish meal may be stable overall, demand for high quality specialized fishmeal products are growing rapidly. Firms that intend to produce high quality, specialized fish meal products are likely to receive higher prices that will grow through time for their products. Processors that produce low temperature, steamed fishmeal will find ready markets for their products from fish feed producers, salmon farmers and other aquaculture operators. Projects that propose to process high quality meals using innovative techniques, such as those being developed in Europe warrant support.

2. Projects that rely totally or partially on groundfish for raw material should be scrutinized carefully to ensure access to adequate supplies exist.

3. Projects that involve pelagic meals that rely on prices exceeding $ 625 per tonne to achieve financial viability warrant careful scrutiny.

APPENDIX 1

DETAILED STATISTICS

1-1	CANADIAN STATISTICS
1-2	WORLD PRODUCTION, GENERAL
1-3	WORLD PRODUCTION, BY COUNTRY
1-4,1-5	CONSUMPTION, BY CONTINENT
1-6,1-7	CONSUMPTION, BY COUNTRY
1-8	EXPORTS, BY COUNTRY
1-9,1-10	IMPORTS, BY COUNTRY
1-11	TOP TEN PRODUCERS
1-12	TOP TEN IMPORTERS
1-13	TOP TEN EXPORTERS
1-14	TOP TEN CONSUMERS

FISH MEAL STATISTICS: CANADA

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PRODUCTION	56.40	74.30	68.77	66.36	76.95	62.42	60.43	63.71	60.09	65.65	64.49	67
% world	1.23%	1.51%	1.35%	1.33%	1.52%	1.16%	1.14%	1.05%	0.96%	0.99%	1.05%	1.06%
PACIFIC:	9.94	11.89	8.62	5.66	8.27	6.20	9.11	6.31	7.27	6.25	5.80	6.0
Herring	na	na	na	na	na	3.45	4.66	3.94	4.55	1.66	na	
Other	na	na	na	na	na	2.75	4.45	2.37	2.72	4.59	na	
ATLANTIC:	46.46	62.41	60.15	60.70	68.68	56.22	51.32	57.40	52.82	59.40	58.69	59.94
Groundfish	35.49	49.16	49.55	45.8	52.19	48.37	42.95	48.12	na	na	na	
Herring	6.84	8.68	7.92	13.53	0	0	7.52	8.28	na	na	na	
Other	4.14	4.57	2.68	1.37	16.49	7.85	0.84	0.99	na	na	na	
IMPORTS	0.46	0.34	0.31	0.32	1.81	2.69	6.06	5.60	0.74	3.00	4.33	
EXPORTS	27.93	36.30	26.14	30.37	32.57	25.74	24.82	21.70	24.85	20.01	23.40	
STOCKS - b			3.48	3.26	2.34	3.81	2.22	1.38	5.47	6.31	1.64	
- a			3.26	2.34	3.81	2.22	1.38	5.47	6.31	1.64	1.98	
CONSUMPTION (Sb+P+I-E-Sa)	28.93	38.34	43.16	37.23	44.72	40.96	42.51	43.52	33.14	53.31	45.42	

na = figures not available

FISH MEAL STATISTICS: WORLD PRODUCTION

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987§	1988§
											estimated	est.
Groundfish Meal	360.5	348.1	357.2	340.9	311.7	304.3	256.3	239.2	216.6	187.2		
Oily-fish Meal	3,943.0	4,258.7	4,472.0	4,371.0	4,485.2	4,780.0	4,731.4	5,549.3	5,755.7	6,262.9		
Other Aquatic Meals	271.9	309.3	260.7	260.0	259.3	309.8	294.9	291.2	302.9	211.2		
Total Meals	4,575.4	4,916.1	5,089.9	4,971.9	5,056.2	5,394.1	5,282.6	6,079.7	6,275.2	6,661.3	6,168.0	6,323.7
Fish Oils	973.8	1,094.1	1,147.4	1,180.7	1,137.7	1,273.9	1,114.8	1,497.7	1,457.1	1,660.4		
Other Aquatic Oils	82.2	76.1	64.8	21.8	16.5	14.2	10.0	10.5	11.9	5.9		
Total Oils & Fats	1,056.0	1,170.2	1,212.2	1,202.5	1,154.2	1,288.1	1,124.8	1,508.2	1,469.0	1,666.3		

§ 1987 & 1988 figures are estimated

FISH MEAL - PRODUCTION STATISTICS By Continent and Major Producers

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988 #
WORLD TOTALS:												estimated
Groundfish Meal	360.5	348.1	357.2	340.9	311.7	304.3	256.3	239.2	216.6	187.2		
Oily-fish Meal	3,943.0	4,238.7	4,472.0	4371	4,485.2	4,780.0	4,731.4	5,549.3	5,755.7	6,262.9		
Other Aquatic Meals	271.9	309.3	260.7	260.0	259.3	309.8	294.9	291.2	302.9	211.2		
Total Meals	4,575.4	4,916.1	5,089.9	4,971.9	5,056.2	5,394.1	5,282.6	6,079.7	6,275.2	6,661.3	6,168.0	6,275.7
AFRICA	199.3	223.0	206.9	192.3	191.1	172.4	213.9	150.8	145.0	168.3	345.0	294.0
	4.4%	4.5%	4.1%	3.9%	3.8%	3.2%	4.0%	2.5%	2.3%	2.5%	5.6%	4.7%
South Africa	176.4	189.3	174.9	154.9	155.4	142.7	172.4	115.2	114.6	124.4	289.0	235.0
	3.9%	3.9%	3.4%	3.1%	3.1%	2.6%	3.3%	1.9%	1.8%	1.9%	4.7%	3.7%
NORTH AMERICA	542.3	658.6	649.4	676.7	621.0	665.4	650.0	605.8	673.9	579.8	667.0	530.0
	11.9%	13.4%	12.8%	13.6%	12.3%	12.3%	12.3%	10.0%	10.7%	8.7%	10.8%	8.4%
Canada	56.40	74.30	68.78	66.36	76.21	63.46	61.22	64.83	65.96	61.15	64.49	67.0
	1.2%	1.5%	1.4%	1.3%	1.5%	1.2%	1.2%	1.1%	1.1%	0.9%	1.0%	1.1%
United States	367.1	476.7	462.0	449.6	405.6	477.1	490.1	455.2	473.9	407.1	470.0	357.0
	8.0%	9.7%	9.1%	9.0%	8.0%	8.8%	9.3%	7.5%	7.6%	6.1%	7.6%	5.7%
SOUTH AMERICA	885.6	1,202.0	1,347.7	1,206.4	1,354.8	1,635.1	1,163.4	1,794.5	2,137.4	2,518.9	1910.7	2300.0
	19.4%	24.5%	26.5%	24.3%	26.8%	30.3%	22.0%	29.5%	34.1%	37.8%	31.0%	36.6%
Chile	255.1	375.0	512.6	571.9	688.3	795.8	827.7	1,022.7	1,111.6	1,282.4	1047.0	1,078.0
	5.6%	7.6%	10.1%	11.5%	13.6%	14.8%	15.7%	16.8%	17.7%	19.3%	17.0%	17.2%
Ecuador	69.8	100.0	77.5	102.9	123.4	114.1	21.9	147.9	255.5	205.8	116.7	132.0
	1.5%	2.0%	1.5%	2.1%	2.4%	2.1%	0.4%	2.4%	4.1%	3.1%	1.9%	2.1%
Peru	497.0	670.0	688.0	458.1	478.3	665.5	251.7	568.4	717.1	973.1	747.0	1,090.0
	10.9%	13.6%	13.5%	9.2%	9.5%	12.3%	4.8%	9.3%	11.4%	14.6%	12.1%	17.4%
ASIA	1,076.2	1,194.2	1,191.7	1,185.5	1,237.0	1,354.7	1,556.8	1,716.3	1,646.5	1,675.3	1,583.0	1,386.0
	23.5%	24.3%	23.4%	23.8%	24.5%	25.1%	29.5%	28.2%	26.2%	25.1%	25.7%	22.1%
Japan	857.2	890.2	895.6	879.9	898.9	1,004.1	1,133.5	1,262.7	1,166.6	1,179.1	1,112.7	1,170
	18.7%	18.1%	17.6%	17.7%	17.8%	18.6%	21.5%	20.8%	18.6%	17.7%	18.0%	18.6%
Thailand	141.6	218.2	186.4	14.2	201.7	211.8	204.8	222.6	220.4	215.0	217.0	216
	3.1%	4.4%	3.7%	0.3%	4.0%	3.9%	3.9%	3.7%	3.5%	3.2%	3.5%	3.4%
EUROPE	1,275.9	1,130.6	1,182.0	1,154.8	1,097.0	965.5	1,092.6	1,134.0	1,012.6	969.0	895.7	1,015.7
	27.9%	23.0%	23.2%	23.2%	21.7%	17.9%	20.7%	18.7%	16.1%	14.5%	14.5%	16.2%
Denmark	316.2	278.1	336.1	357.9	337.8	319.6	321.5	318.8	287.4	307.8	270.0	338.0
	6.9%	5.7%	6.6%	7.2%	6.7%	5.9%	6.1%	5.2%	4.6%	4.6%	4.4%	5.4%
Iceland	162.7	202.2	207.9	172.1	148.4	51.1	68.1	171.7	174.8	178.5	171.0	189.0
	3.6%	4.1%	4.1%	3.5%	2.9%	0.9%	1.3%	2.8%	2.8%	2.7%	2.8%	3.0%
Norway	464.8	331.5	327.9	297.7	299.5	284.3	346.9	286.6	238.3	194.1	186.0	184.0
	10.2%	6.7%	6.4%	6.0%	5.9%	5.3%	6.6%	4.7%	3.8%	2.9%	3.0%	2.9%
OCEANIA	4.4	4.4	1.6	0.8	1.0	0.7	0.7	4.5	2.3	3.5		
	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%		
USSR	591.6	503.4	510.7	355.3	354.4	600.2	605.2	673.6	657.5	746.5	766.6	730
	12.9%	10.2%	10.0%	11.2%	11.0%	11.1%	11.5%	11.1%	10.5%	11.2%	12.4%	12.0%

FISH MEAL CONSUMPTION by Continent

T 1,000 at	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
	68.7%	73.8%	76.4%	74.6%	75.9%	81.0%	79.3%	91.3%	94.2%	100.0%
WORLD	100.0%	107.4%	111.2%	108.7%	110.5%	117.9%	115.5%	132.9%	137.2%	145.6%
Production	4,575.4	4,916.1	5,089.9	4,971.9	5,056.2	5,394.1	5,282.6	6,079.7	6,275.2	6,661.3
Imports	2,204.1	2,087.1	2,469.6	2,262.8	2,052.2	2,603.0	2,325.2	2,520.4	3,104.0	3,242.7
Exports	2,041.6	2,072.3	2,330.1	2,352.8	2,149.0	2,658.7	2,321.4	2,656.4	3,228.8	3,253.0
Consumption	4,737.9	4,930.9	5,229.4	4,881.9	4,959.4	5,338.4	5,286.4	5,943.7	6,150.4	6,651.0
Cons. as % of prod.	103.6%	100.3%	102.7%	98.2%	98.1%	99.0%	100.1%	97.8%	98.0%	99.8%
AFRICA										
% of 1986 production	118.4%	132.5%	122.9%	114.3%	113.5%	102.4%	127.1%	89.6%	86.2%	100.0%
% of 1977 production	100.0%	111.9%	103.8%	96.5%	95.9%	86.5%	107.3%	75.7%	72.8%	84.4%
Production	199.3	223.0	206.9	192.3	191.1	172.4	213.9	150.8	145.0	168.3
Imports	20.5	38.7	25.2	33.8	71.6	129.1	149.5	178.5	162.4	158.5
Exports	16.8	35.2	58.0	35.2	26.5	7.8	21.3	10.4	9.5	4.8
Consumption	203.0	226.5	174.1	190.9	236.2	293.7	342.1	318.9	297.9	322.0
Cons. as % of prod.	101.9%	101.6%	84.1%	99.3%	123.6%	170.4%	159.9%	211.5%	205.4%	191.3%
as % of WORLD prod.	4.4%	4.6%	3.4%	3.8%	4.7%	5.4%	6.5%	5.2%	4.7%	4.8%
NORTH AMERICA										
% of 1986 production	93.5%	113.6%	112.0%	116.7%	107.1%	114.8%	112.1%	104.5%	116.2%	100.0%
% of 1977 production	100.0%	121.4%	119.7%	124.8%	114.5%	122.7%	119.9%	111.7%	124.3%	106.9%
Production	542.3	658.6	649.4	676.7	621.0	665.4	650.0	605.8	673.9	579.8
Imports	128.8	126.4	185.7	167.1	134.2	128.1	89.2	104.4	242.4	189.0
Exports	126.9	120.9	82.8	153.7	89.8	49.5	112.2	49.3	95.5	69.2
Consumption	544.2	664.1	752.3	690.1	665.4	744.0	627.0	660.9	820.8	699.6
Cons. as % of prod.	100.4%	100.8%	115.8%	102.0%	107.1%	111.8%	96.5%	109.1%	121.8%	120.7%
as % of WORLD prod.	11.9%	13.5%	14.8%	13.9%	13.2%	13.8%	11.9%	10.9%	13.1%	10.5%
SOUTH AMERICA										
% of 1986 production	35.2%	47.7%	53.3%	47.9%	53.8%	64.9%	46.2%	71.2%	84.9%	100.0%
% of 1977 production	100.0%	135.7%	152.2%	136.2%	153.0%	184.6%	131.4%	202.6%	241.4%	284.4%
Production	885.6	1,202.0	1,347.7	1,206.4	1,354.8	1,635.1	1,163.4	1,794.5	2,137.4	2,518.9
Imports	9.0	21.2	34.5	41.0	47.5	58.8	39.3	62.8	38.3	40.0
Exports	709.3	818.5	996.6	1,023.4	950.3	1,490.2	1,007.5	1,285.2	1,864.8	1,948.7
Consumption	185.3	404.7	385.6	224.0	452.0	203.7	195.2	572.1	310.9	610.2
Cons. as % of prod.	20.9%	33.7%	28.6%	18.6%	33.4%	12.5%	16.8%	31.9%	14.5%	24.2%
as % of WORLD prod.	4.0%	8.2%	7.6%	4.5%	8.9%	3.8%	3.7%	9.4%	5.0%	9.2%
ASIA										
% of 1986 production	64.2%	71.3%	71.1%	70.8%	73.8%	80.9%	92.9%	102.4%	98.3%	100.0%
% of 1977 production	100.0%	111.0%	110.7%	110.2%	114.9%	125.9%	144.7%	159.5%	153.0%	155.7%
Production	1,076.2	1,194.2	1,191.7	1,185.5	1,237.0	1,354.7	1,356.8	1,716.3	1,646.5	1,675.3
Imports	317.6	411.2	502.4	513.8	530.8	699.0	587.7	719.2	846.1	986.3
Exports	155.0	206.3	222.3	198.1	225.1	277.4	234.1	293.0	318.7	361.4
Consumption	1,438.8	1,399.1	1,471.8	1,501.2	1,542.7	1,776.3	1,910.4	2,142.5	2,173.9	2,300.2
Cons. as % of prod.	133.7%	117.2%	123.5%	126.6%	124.7%	131.1%	122.7%	124.8%	132.0%	137.3%
as % of WORLD prod.	31.4%	28.5%	28.9%	30.2%	30.5%	32.9%	36.2%	35.2%	34.6%	34.5%

FISH MEAL CONSUMPTION By Continent

I 1,000 mt	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
EUROPE										
I of 1986 production	131.7%	116.7%	122.0%	119.2%	113.2%	99.6%	112.8%	117.0%	104.5%	100.0%
I of 1977 production	100.0%	88.6%	92.6%	90.5%	86.0%	75.7%	85.6%	88.9%	79.4%	75.9%
Production	1,275.9	1,130.6	1,182.0	1,154.8	1,097.0	965.5	1,092.6	1,134.0	1,012.6	969.0
Imports	1,505.7	1,486.7	1,717.5	1,491.9	1,259.0	1,579.5	1,448.4	1,386.9	1,719.1	1,772.1
Exports	1,019.7	869.9	949.7	919.6	845.0	824.8	934.7	1,007.0	929.3	855.4
Consumption	1,761.9	1,747.4	1,949.8	1,727.1	1,511.0	1,720.2	1,606.3	1,513.9	1,802.4	1,885.7
Cons. as I of prod.	138.1%	154.6%	165.0%	149.6%	137.7%	178.2%	147.0%	133.5%	178.0%	194.6%
as I of WORLD prod.	38.5%	35.5%	38.3%	34.7%	29.9%	31.9%	30.4%	24.9%	28.7%	28.3%
OCEANIA										
I of 1986 production	125.7%	125.7%	45.7%	22.9%	28.6%	20.0%	20.0%	128.6%	65.7%	100.0%
I of 1977 production	100.0%	100.0%	36.4%	18.2%	22.7%	15.9%	15.9%	102.3%	52.3%	79.5%
Production	4.4	4.4	1.6	0.8	1.0	0.7	0.7	4.5	2.3	3.5
Imports	7.7	2.8	4.3	15.2	9.0	8.5	11.0	8.6	12.7	8.0
Exports	0.3	0.0	0.2	0.2	0.5	0.0	0.1	3.9	0.5	1.6
Consumption	11.8	7.2	5.7	15.8	9.5	9.2	11.6	9.2	14.5	9.9
Cons. as I of prod.	268.2%	163.6%	356.3%	1975.0%	950.0%	1314.3%	1657.1%	204.4%	630.4%	282.9%
as I of WORLD prod.	0.3%	0.1%	0.1%	0.3%	0.2%	0.2%	0.2%	0.2%	0.2%	0.1%
USSR										
I of 1986 production	79.2%	67.4%	68.4%	74.4%	74.3%	80.4%	81.1%	90.2%	88.1%	100.0%
I of 1977 production	100.0%	85.1%	86.3%	93.9%	93.7%	101.5%	102.3%	113.9%	111.1%	126.2%
Production	591.6	503.4	510.7	555.3	554.4	600.2	605.2	673.6	657.5	746.5
Imports	14.7	0.0	0.0	0.0	0.0	0.0	0.0	60.0	82.9	88.8
Exports	13.6	21.5	20.3	22.5	11.9	8.9	11.4	7.6	10.4	11.8
Consumption	592.7	481.9	490.4	532.8	542.5	591.3	593.8	726.0	730.0	823.5
Cons. as I of prod.	100.2%	95.7%	96.0%	95.9%	97.9%	98.5%	98.1%	107.8%	111.0%	110.3%
as I of WORLD prod.	13.0%	9.8%	9.6%	10.7%	10.7%	11.0%	11.2%	11.9%	11.6%	12.4%

FISH MEAL CONSUMPTION by Major Consumers

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 e
GERMANY FR											estimated
Production	48.6	44.7	40.0	37.0	38.5	36.9	35.8	36.8	33.2	29.9	
Imports	307.5	277.1	282.8	311.5	214.7	356.3	351	311.9	418.3	478.3	400
Exports	58.6	55.9	62.4	88.2	95.8	188	188.9	222.7	235.9	220.7	205
Consumption	297.5	265.9	260.4	260.3	157.4	205.2	197.9	126	215.6	287.5	230
% world production	7%	5%	5%	5%	3%	4%	4%	2%	3%	4%	4%
% own production	612%	595%	651%	704%	409%	356%	353%	342%	649%	962%	ERR
UK											
Production	78.0	66.0	58.6	68.3	59.7	56.4	54.2	50.5	53.0	47.0	
Imports	218.8	192.3	255.7	214.9	173.5	213.5	162.6	173.7	236.8	236.9	249
Exports	10.8	9.1	6.5	8.2	3.3	2.0	3.4	2.3	3.2	6.8	
Consumption	286	249.2	307.8	275	229.9	267.9	213.4	221.9	286.6	277.1	290
% world production	6%	5%	6%	6%	5%	5%	4%	4%	5%	4%	5%
% own production	367%	378%	525%	403%	385%	475%	394%	439%	541%	590%	ERR
CHINA											
Production	0.0	0.0	0.0	0.0	0.0	0.0	50.0	53.0	55.0	51.0	
Imports	5.0	15.6	23.3	19.4	14.9	85.3	58.4	108.2	198.6	193.6	270
Exports	0.2	0.5	0.3	0.4	0.3	0.3	0.8	1.2	0.5	0.9	
Consumption	4.8	15.1	23	19	14.6	85	107.6	160	253.1	243.7	280
% world production	0%	0%	0%	0%	0%	2%	2%	3%	4%	4%	5%
% own production	ERR	ERR	ERR	ERR	ERR	ERR	215%	302%	460%	478%	ERR
USA											
Production	367.1	476.7	462	449.6	405.6	477.1	490.1	455.2	473.9	407.1	470
Imports	73.9	39.8	81.3	44.9	53.9	76.5	61.6	75.7	233	168.1	180
Exports	32.8	46	14.2	77.4	42.7	16.3	70.2	18.3	31.4	34.9	64
Consumption	408.2	470.5	529.1	417.1	416.8	537.3	481.5	512.6	675.5	540.3	586
% world production	9%	10%	10%	8%	8%	10%	9%	8%	.11%	8%	10%
% own production	111%	99%	115%	93%	103%	113%	98%	113%	143%	133%	125%
Japan											
Production	857.2	890.2	895.6	879.9	898.9	1004.1	1133.5	1262.7	1166.6	1179.1	1112.7
Imports	181.1	84.9	101.6	141	84.1	44.3	95.1	61.6	80.3	161.5	205
Exports	37.5	64.3	57.7	43.3	73.7	135.7	79.6	135.3	157.4	167.2	200
Consumption	1000.8	910.8	939.5	977.6	909.3	912.7	1149	1189	1089.5	1173.4	1117.7
% world production	22%	19%	18%	20%	18%	17%	22%	20%	17%	18%	18%
% own production	117%	102%	105%	111%	101%	91%	101%	94%	93%	100%	100%
Netherlands											
Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Imports	54.0	54.5	54.5	47.5	38.1	72.8	44.9	49.9	95.8	115.9	118.0
Exports	9.0	6.6	12.9	11.9	11.2	14.6	11.4	13.6	21.8	26.7	
Consumption	45	47.9	41.6	35.6	26.9	58.2	33.5	36.3	74	89.2	83
% world production	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%
% own production	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
Yugoslavia											
Production	1.7	2.0	1.8	2.1	1.8	2.2	2.3	2.1	2.3	2.8	
Imports	80.9	82.1	82.3	79.3	89.2	78.6	122.6	82.4	96.9	114.3	95
Exports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Consumption	82.6	84.1	84.1	81.4	91	80.8	124.9	84.5	99.2	117.1	100
% world production	2%	2%	2%	2%	2%	1%	2%	1%	2%	2%	2%
% own production	4859%	4205%	4672%	3876%	5056%	3673%	5430%	4024%	4313%	4182%	ERR

FISH MEAL CONSUMPTION by Major Consumers

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 e
Sweden											estimated
Production	10.3	9.5	8.0	11.5	13.1	11.4	11.5	13.0	10.5	12.0	
Imports	70.5	78.6	99.7	97.8	90	114.7	119.6	124.1	113.3	108.6	80
Exports	0.8	1.0	0.7	0.7	0.6	0.8	0.6	0.9	0.0	2.9	
Consumption	80	87.1	107	108.6	102.5	125.3	130.5	136.2	123.8	117.7	90
% world production	2%	2%	2%	2%	2%	2%	2%	2%	2%	2%	1%
% own production	777%	917%	1338%	944%	782%	1099%	1135%	1048%	1179%	981%	ENR
Italy											
Production	1.0	4.8	6.6	6.3	7.6	9.1	3.3	4.1	3.2	4.6	
Imports	70.8	89.1	105.2	81.8	61.5	76.4	78.4	60	108	101.8	100
Exports	3.2	2.0	10.8	4.6	3.1	11.1	35.9	21.4	43.4	29.5	
Consumption	68.6	91.9	101	83.5	66	74.4	45.8	42.7	67.8	76.9	75
% world production	1%	2%	2%	2%	1%	1%	1%	1%	1%	1%	1%
% own production	6860%	1915%	1530%	1325%	868%	818%	1388%	1041%	2119%	1672%	ENR
USSR											
Production	591.6	503.4	510.7	555.3	554.4	600.2	605.2	673.6	657.5	746.5	766.6
Imports	14.7	0	0	0	0	0	0	60	82.9	88.8	60
Exports	13.6	21.5	20.3	22.5	11.9	8.9	11.4	7.6	10.4	11.8	0
Consumption	592.7	481.9	490.4	532.8	542.5	591.3	593.8	726	730	823.5	826.6
% world production	13%	10%	10%	11%	11%	11%	11%	12%	12%	12%	13%
% own production	100%	96%	96%	96%	98%	99%	98%	108%	111%	110%	108%
Norway											
Production	464.8	331.5	327.9	297.7	299.5	284.3	346.9	285.6	238.3	194.1	186
Imports	0	0	0	0	0	0	0	0	0	0	0
Exports	461.6	283.7	326.6	274.7	266.3	228.4	283.7	248.4	173.7	92.3	80
Consumption	3.2	47.8	1.3	23	33.2	55.9	63.2	38.2	64.6	101.8	106
% world production	0%	1%	0%	0%	1%	1%	1%	1%	1%	2%	2%
% own production	1%	14%	0%	8%	11%	20%	18%	13%	27%	52%	57%
Thailand											
Production	141.6	218.2	186.4	14.2	201.7	211.8	204.8	222.4	220.4	215.0	
Imports	0	0	0	0	0	0	0	0	0	0	
Exports	78.8	109.8	138.7	126.5	134.1	103.9	128.0	129.3	128.5	141.8	
Consumption	62.8	108.4	47.7	-112.3	67.6	107.9	76.8	93.3	91.9	73.2	
% world production	1%	2%	1%	-2%	1%	2%	1%	2%	1%	1%	0%
% own production	44%	50%	26%	-791%	34%	51%	38%	42%	42%	34%	ENR
South Africa											
Production	176.4	189.3	174.9	154.9	155.4	142.7	172.4	115.2	114.6	124.4	209
Imports	0.0	0.0	0.0	0.0	22.4	69.0	55.0	55.4	94.6	72.0	10.0
Exports	8.0	8.0	37.8	17.8	6.9	6.4	9.0	3.3	4.0	4.0	8.0
Consumption	168.4	181.3	137.1	137.1	170.9	207.3	216.4	167.3	205.2	192.4	150
% world production	4%	4%	3%	3%	3%	4%	4%	3%	3%	3%	2%
% own production	95%	96%	78%	89%	110%	145%	126%	145%	179%	155%	72%
Peru											
Production	497	670	688	458.1	478.3	665.5	251.7	568.4	717.1	973.1	747
Imports	0	0	0	0	0	0	0	0	0	0	0
Exports	442.3	473.4	530.9	463.7	389.2	604.8	209.6	389.2	507.6	679	730
Consumption	54.7	196.6	157.1	-5.6	89.1	60.7	42.1	179.2	209.5	294.1	17
% world production	1%	4%	3%	0%	2%	1%	1%	3%	3%	4%	0%
% own production	11%	29%	23%	-1%	19%	9%	17%	32%	29%	30%	2%
Taiwan											
Production	0	0	0	0	0	0	0	0	0	0	0
Imports	3.5	11.1	18.1	23.4	53.9	72.9	52.1	48.3	49.1	46	0
Exports	0	0	0	0	0	0	0	0	0	0	0
Consumption	3.5	11.1	18.1	23.4	53.9	72.9	52.1	48.3	49.1	46	0
% world production	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	0%
% own production	ENR	ENR	ENR	ENR	ENR	ENR	ENR	ENR	ENR	ENR	ENR

FISH MEAL - EXPORT STATISTICS — By Continent and Major Exporters

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 #
WORLD TOTALS:											estimated
Developed Countries	1,139.6	1,046.2	1,106.0	1,111.5	1,013.4	1,016.2	1,130.0	1,197.8	1,159.9	1,094.9	
Developing Countries	902.0	1,026.1	1,224.1	1,241.3	1,135.6	1,642.5	1,191.4	1,458.6	2,068.9	2,158.1	
Total Exports	2,041.6	2,072.3	2,330.1	2,352.8	2,149.0	2,658.7	2,321.4	2,656.4	3,228.8	3,253.0	3100
AFRICA	16.8	35.2	58.0	35.2	26.5	7.8	21.3	10.4	9.5	4.8	
	0.8%	1.7%	2.5%	1.5%	1.2%	0.3%	0.9%	0.4%	0.3%	0.1%	
South Africa	8.00	8.00	37.80	17.80	6.90	4.40	9.00	3.30	4.00	4.00	
	0.4%	0.4%	1.6%	0.8%	0.3%	0.2%	0.4%	0.1%	0.1%	0.1%	
NORTH AMERICA	126.9	120.9	82.8	153.7	89.8	49.5	112.2	49.3	95.5	69.2	
	6.2%	5.8%	3.6%	6.5%	4.2%	1.9%	4.8%	1.9%	3.0%	2.1%	
Canada	27.93	36.30	26.14	30.71	32.81	26.09	24.90	22.39	26.85	20.01	
	1.4%	1.8%	1.1%	1.3%	1.5%	1.0%	1.1%	0.8%	0.8%	0.6%	
United States	32.8	46.0	14.2	77.4	42.7	16.3	70.2	18.3	31.4	34.9	64
	1.6%	2.2%	0.6%	3.3%	2.0%	0.6%	3.0%	0.7%	1.0%	1.1%	2.1%
SOUTH AMERICA	709.3	818.5	996.6	1,023.4	950.3	1,490.2	1,007.5	1,285.2	1,864.8	1,948.7	
	34.7%	39.5%	42.8%	43.5%	44.2%	56.0%	43.4%	48.4%	57.8%	59.9%	
Chile	204.2	277.4	387.2	465.1	455.8	772.7	755.1	781.5	1,109.0	1,081.6	1096
	10.0%	13.4%	16.6%	19.8%	21.2%	29.1%	32.5%	29.4%	34.3%	33.2%	35.4%
Ecuador	55.2	59.9	74.7	87.9	89.4	102.1	24.5	98.2	232.9	176.5	90
	2.7%	2.9%	3.2%	3.7%	4.2%	3.8%	1.1%	3.7%	7.2%	5.4%	2.9%
Peru	442.3	473.4	530.9	463.7	389.2	604.8	209.6	389.2	507.6	679.0	730
	21.7%	22.8%	22.8%	19.7%	18.1%	22.7%	9.0%	14.7%	15.7%	20.9%	23.5%
ASIA	155.0	206.3	222.3	198.1	225.1	277.4	234.1	293.0	318.7	361.4	
	7.6%	10.0%	9.5%	8.4%	10.5%	10.4%	10.1%	11.0%	9.9%	11.1%	
Japan	37.5	64.3	57.7	43.3	73.7	135.7	79.6	135.3	157.4	167.2	200
	1.8%	3.1%	2.5%	1.8%	3.4%	5.1%	3.4%	5.1%	4.9%	5.1%	6.5%
Thailand	78.8	109.8	138.7	126.5	134.1	103.9	128.0	129.3	128.5	141.8	130
	3.9%	5.3%	6.0%	5.4%	6.2%	3.9%	5.5%	4.9%	4.0%	4.4%	4.2%
EUROPE	1,019.7	869.9	949.7	919.6	845.0	824.8	934.7	1,007.0	929.3	855.4	
	49.9%	42.0%	40.8%	39.1%	39.3%	31.0%	40.3%	37.9%	28.8%	26.3%	
Denmark	270.0	251.6	266.6	301.4	274.4	259.3	273.7	264.6	223.2	230.5	210
	13.2%	12.1%	11.4%	12.8%	12.8%	9.8%	11.8%	10.0%	6.9%	7.1%	6.8%
Germany FR	58.6	55.9	62.4	88.2	95.8	188.0	188.9	222.7	235.9	220.7	205
	2.9%	2.7%	2.7%	3.7%	4.5%	7.1%	8.1%	8.4%	7.3%	6.8%	6.6%
Iceland	146.1	196.4	204.2	166.3	129.9	64.5	48.5	138.5	162.2	192.1	160
	7.2%	9.5%	8.8%	7.1%	6.0%	2.4%	2.1%	5.2%	5.0%	5.9%	5.2%
Norway	461.6	283.7	326.6	274.7	266.3	228.4	283.7	248.4	173.7	92.3	80
	22.6%	13.7%	14.0%	11.7%	12.4%	8.6%	12.2%	9.4%	5.4%	2.8%	2.6%
OCEANIA	0.3	0.0	0.2	0.2	0.5	0.0	0.1	3.9	0.5	1.6	
	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	
USSR	13.6	21.3	20.3	22.3	11.9	8.9	11.4	7.6	10.4	11.8	
	0.7%	1.0%	0.9%	1.0%	0.6%	0.3%	0.5%	0.3%	0.3%	0.4%	

FISH MEAL - IMPORT STATISTICS — By Continent and Major Importers

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 e
WORLD TOTALS:											estimated
Developed Countries	1,801.4	1,624.5	1,919.4	1,694.4	1,433.3	1,787.3	1,687.0	1,667.4	2,230.1	2,279.7	
Developing Countries	402.7	462.6	550.2	568.4	618.9	815.7	638.2	853.0	873.9	963.0	
Total Imports	2,204.1	2,087.1	2,469.6	2,262.8	2,052.2	2,603.0	2,325.2	2,520.4	3,104.0	3,242.7	3165
AFRICA	20.5	38.7	25.2	33.8	71.6	129.1	149.5	178.5	162.4	158.5	
	0.9%	1.9%	1.0%	1.5%	3.5%	5.0%	6.4%	7.1%	5.2%	4.9%	
Egypt	5.6	12.6	3.0	9.6	23.9	25.8	47.5	45.5	25.0	40.0	
	0.3%	0.6%	0.1%	0.4%	1.2%	1.0%	2.0%	1.8%	0.8%	1.2%	
South Africa	0.0	0.0	0.0	0.0	22.4	69.0	53.0	55.4	94.6	72.0	10
	0.0%	0.0%	0.0%	0.0%	1.1%	2.7%	2.3%	2.2%	3.0%	2.2%	0.3%
NORTH AMERICA	128.8	126.4	185.7	167.1	134.2	128.1	89.2	104.4	242.4	189.0	
	5.8%	6.1%	7.5%	7.4%	6.5%	4.9%	3.8%	4.1%	7.8%	5.8%	
Canada	0.46	0.34	0.31	0.32	1.80	2.70	6.10	5.60	0.74	3.00	
	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.3%	0.2%	0.0%	0.1%	
Mexico	12.3	24.0	42.1	27.3	23.8	30.7	8.1	20.0	4.3	12.0	
	0.6%	1.1%	1.7%	1.2%	1.2%	1.2%	0.3%	0.8%	0.1%	0.4%	
United States	73.9	39.8	81.3	44.9	53.9	76.5	61.6	75.7	233.0	168.1	180
	3.4%	1.9%	3.3%	2.0%	2.6%	2.9%	2.6%	3.0%	7.5%	5.2%	5.7%
SOUTH AMERICA	9.0	21.2	34.5	41.0	47.5	58.8	39.3	62.8	38.3	40.0	
	0.4%	1.0%	1.4%	1.8%	2.3%	2.3%	1.7%	2.5%	1.2%	1.2%	
Columbia	8.4	15.3	33.0	38.1	43.7	54.3	39.2	62.1	38.3	40.0	
	0.4%	0.7%	1.3%	1.7%	2.1%	2.1%	1.7%	2.5%	1.2%	1.2%	
ASIA	517.6	411.2	502.4	513.8	530.8	699.0	587.7	719.2	846.1	986.3	
	23.5%	19.7%	20.3%	22.7%	25.9%	26.9%	25.3%	28.5%	27.3%	30.4%	
China	5.0	15.6	23.3	19.4	14.9	85.3	58.4	108.2	198.6	193.6	270
	0.2%	0.7%	0.9%	0.9%	0.7%	3.3%	2.5%	4.3%	6.4%	6.0%	8.5%
Indonesia	3.5	11.1	18.1	23.4	53.9	72.9	52.1	45.3	49.1	46.0	
	0.2%	0.5%	0.7%	1.0%	2.6%	2.8%	2.2%	1.8%	1.6%	1.4%	
Iran I R	130.1	43.0	54.3	66.5	118.3	76.3	36.2	74.2	52.0	74.0	
	5.9%	2.1%	2.2%	2.9%	5.8%	2.9%	1.6%	2.9%	1.7%	2.3%	
Japan	181.1	84.9	101.6	141.0	84.1	44.3	95.1	61.6	80.3	161.5	205
	8.2%	4.1%	4.1%	6.2%	4.1%	1.7%	4.1%	2.4%	2.6%	5.0%	6.5%
Malaysia	19.4	35.8	35.8	34.7	30.9	44.5	35.9	61.1	56.3	53.6	
	0.9%	1.7%	1.4%	1.4%	2.2%	1.4%	2.6%	2.2%	1.7%	0.0%	
Singapore	47.0	32.3	60.1	54.6	44.1	61.1	39.4	47.3	38.8	41.0	
	2.1%	2.5%	2.4%	2.4%	2.1%	2.3%	1.7%	1.9%	1.3%	1.3%	
Taiwan	89.9	126.0	144.7	125.5	146.9	226.3	204.6	261.9	308.7	332.0	430
	4.1%	6.0%	5.9%	5.5%	7.2%	8.7%	8.8%	10.4%	9.9%	10.2%	13.6%

FISH MEAL - IMPORT STATISTICS by Continent and Major Importers

x 1,000 MT	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987 e estimated
EUROPE	1,506	1,487	1,718	1,492	1,259	1,580	1,448	1,387	1,719	1,772	
	68.3%	71.2%	69.5%	65.9%	61.3%	60.7%	62.3%	55.0%	55.4%	54.6%	
Finland	44.3	58.8	77.7	90.0	88.8	96.7	91.7	86.4	89.3	67.9	
	2.0%	2.8%	3.1%	4.0%	4.3%	3.7%	3.9%	3.4%	2.9%	2.1%	
France	59.6	54.8	61.0	60.8	51.1	60.5	56.8	55.0	68.8	67.2	73
	2.7%	2.6%	2.5%	2.7%	2.5%	2.3%	2.4%	2.2%	2.2%	2.1%	2.3%
Germany FR	307.5	277.1	282.8	311.5	214.7	356.3	351.0	311.9	418.3	478.3	400
	14.0%	13.3%	11.5%	13.8%	10.5%	13.7%	15.1%	12.4%	13.5%	14.8%	12.6%
Hungary	52.5	49.4	39.8	35.7	40.0	62.3	65.4	77.8	87.6	78.1	60
	2.4%	2.4%	1.6%	1.6%	1.9%	2.4%	2.8%	3.1%	2.8%	2.4%	1.9%
Italy	70.8	89.1	105.2	81.8	61.5	76.4	78.4	60.0	108.0	101.8	100
	3.2%	4.3%	4.3%	3.6%	3.0%	2.9%	3.4%	2.4%	3.5%	3.1%	3.2%
Netherlands	54.0	54.5	54.5	47.5	38.1	72.8	44.9	49.9	95.8	115.9	118
	2.4%	2.6%	2.2%	2.1%	1.9%	2.8%	1.9%	2.0%	3.1%	3.6%	3.7%
Sweden	70.5	78.6	99.7	97.8	90.0	114.7	119.6	124.1	113.3	108.6	80
	3.2%	3.8%	4.0%	4.3%	4.4%	4.4%	5.1%	4.9%	3.7%	3.3%	2.5%
Switzerland	91.1	103.4	99.0	91.9	105.1	91.8	95.7	81.3	80.4	72.3	
	4.1%	5.0%	4.0%	4.1%	5.1%	3.5%	4.1%	3.2%	2.6%	2.2%	
UK	218.8	192.3	255.7	214.9	173.5	213.5	162.6	173.7	236.8	236.9	249
	9.9%	9.2%	10.4%	9.5%	8.5%	8.2%	7.0%	6.9%	7.6%	7.3%	7.9%
Yugoslavia	80.9	82.1	82.3	79.3	89.2	78.6	122.6	82.4	96.9	114.3	95
	3.7%	3.9%	3.3%	3.5%	4.3%	3.0%	5.3%	3.3%	3.1%	3.5%	3.0%
OCEANIA	7.7	2.8	4.3	13.2	9.0	8.5	11.0	8.6	12.7	8.0	
	0.3%	0.1%	0.2%	0.7%	0.4%	0.3%	0.5%	0.3%	0.4%	0.2%	
USSR	14.7	0.0	0.0	0.0	0.0	0.0	0.0	60.0	82.9	88.8	60
	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	2.7%	2.7%	1.9%

MAJOR FISH MEAL PRODUCERS

x 1,000 MT

1988 RANK	MAJOR PRODUCERS	1982-86	%	1986	%	1987	%	1988#	%
	World total	5,938.6		6,661.3		6,168.0		6,275.7	
1	Japan	1,149.2	19%	1,179.1	18%	1,112.7	18%	1,170.0	19%
3	Chile	1,008.0	17%	1,282.4	19%	1,047.0	17%	1,078.0*	17%
4	USSR	656.6	11%	746.5	11%	766.6	12%	750.0	12%
2	Peru	635.2	11%	973.1	15%	747.0	12%	1,090.0*	17%
5	USA	460.7	8%	407.1	6%	470.0	8%	357.0*	6%
6	Denmark	311.4	5%	307.8	5%	270.0	4%	338.0*	5%
10	Norway	270.0	5%	194.1	3%	186.0	3%	184.0*	3%
8	Thailand	214.9	4%	215.0	3%	217.0	4%	216.0	3%
	Ecuador	149.0	3%	205.8	3%	116.7	2%	132.0	2%
7	South Africa	133.9	2%	124.4	2%	289.0	5%	235.0*	4%
	subtotal:	4,989.0	84%	5,635.3	85%	5,222.0	85%	5,550.0	88%
	Canada	63.3	1.1%	61.2	1.0%	64.5	1.0%	67.0	1.1%
9	Iceland			178.0	3%	171.0	3%	189.0	3%

\# The starred numbers for 1988 are based on data from the International Association of Fish Meal Manufacturers (IAFMM). The other numbers are estimates based on USDA and Oil World figures.

MAJOR FISH MEAL IMPORTERS

x 1,000 MT

1987 RANK	MAJOR IMPORTERS	1982-86	%	1986	%	1987#	%
	World total	2,759.1		3,242.7		3,165.0	
2	West Germany	383.2	14%	478.3	15%	400.0	13%
1	Taiwan	266.7	10%	332.0	10%	430.0	14%
3	UK	204.7	7%	236.9	7%	250.0	8%
4	China	128.8	5%	193.6	6%	230.0	7%
6	USA	123.0	4%	168.1	5%	180.0	6%
10	Sweden	116.1	4%	108.6	3%	80.0	3%
9	Yugoslavia	99.0	4%	114.3	4%	95.0	3%
5	Japan	88.6	3%	161.5	5%	210.0	7%
8	Italy	84.9	3%	101.8	3%	100.0	3%
7	Netherlands	75.9	3%	115.9	4%	118.0	4%
	subtotal:	1,570.7	57%	2,011.0	62%	2,093.0	66%
	Canada	3.6	0.1%	3.0	0.1%	4.3	0.1%

1987 numbers are estimates based on FAO and USDA data.

MAJOR FISH MEAL EXPORTERS

x 1,000 MT

1987 RANK	MAJOR EXPORTERS	1982-86	%	1986	%	1987#	%
	World total	2,823.7		3,253.0		3,100.0	
1	Chile	900.0	32%	1,081.6	33%	1,096.0	35%
2	Peru	478.0	17%	679.0	21%	730.0	24%
3	Denmark	250.3	9%	230.5	7%	210.0	7%
4	Germany FR	211.2	7%	220.7	7%	205.0	7%
9	Norway	205.3	7%	92.3	3%	80.0	3%
5	Japan	135.0	5%	167.2	5%	200.0	6%
8	Ecuador	126.8	4%	176.5	5%	90.[illegible]	3%
7	Thailand	126.3	4%	141.8	4%	130.[illegible]	4%
6	Iceland	121.2	4%	192.1	6%	160.0	5%
10	USA	34.2	1%	34.9	1%	64.0	2%
	subtotal:	2,588.4	92%	3,016.6	93%	2,965.0	96%
	Canada	24.0	0.9%	20.0	0.6%	23.4	0.8%

1987 numbers are estimates based on FAO and USDA data.

MAJOR FISH MEAL CONSUMERS

x 1,000 MT

1987 RANK	MAJOR CONSUMERS	1982-86	%	1986	%	1987#	%
	World total	5,874.0		6,651.0		6,233.0	
1	Japan	1,102.7	19%	1,173.4	18%	1,117.7	18%
2	USSR	692.9	12%	823.5	12%	826.6	13%
3	USA	549.4	9%	540.3	8%	586.0	9%
5	UK	253.4	4%	277.1	4%	290.0	5%
7	West Germany	206.4	4%	287.5	4%	230.0	4%
9	South Africa	197.7	3%	192.4	3%	150.0	2%
6	China	169.9	3%	243.7	4%	280.0	4%
4	Peru	157.1	3%	294.1	4%	300.0	5%
	Sweden	126.7	2%	117.7	2%	90.0	1%
10	Yugoslavia	101.3	2%	117.1	2%	100.0	2%
	subtotal:	3,557.6	61%	4,066.8	61%	3,970.3	64%
	Canada	42.1	0.7%	50.5	0.8%	45.4	0.7%
8	Taiwan					210.0	3%

All numbers are based on the formula: production + imports-exports = consumption. There is no allowance for inventory change.

APPENDIX II

FISH MEAL PLANTS

11-1	NEW BRUNSWICK
	QUEBEC
11-2	NOVA SCOTIA
	PRINCE EDWARD ISLAND
11-3	NEWFOUNDLAND

FISH MEAL PLANTS

NEW BRUNSWICK

1. LOWER CARAQUET
2. LAMEQUE
3. SHIPPAGON
4. BLACKS HARBOUR
5. ST. ANDREWS

QUEBEC

1. RIVIERE AU RENARD, GASPE
2. GRINDSTONE, MAGDELENE ISLANDS

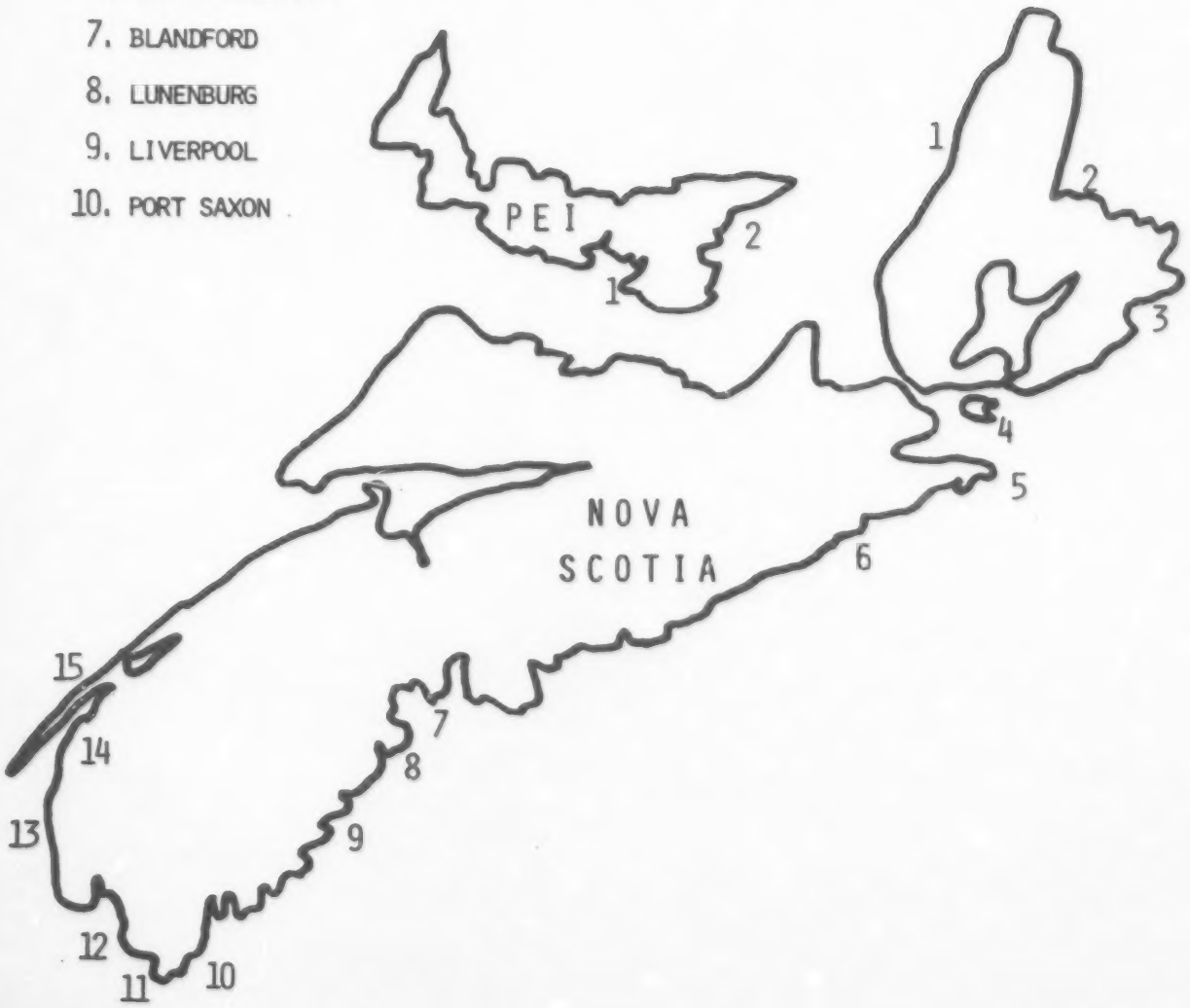
FISH MEAL PLANTS

NOVA SCOTIA

1. CHETICAMP
2. ALDER POINT
3. LOUISBURG
4. PETIT DE GRAT
5. CANSO
6. PORT BICKERTON
7. BLANDFORD
8. LUNENBURG
9. LIVERPOOL
10. PORT SAXON
11. WOOD HARBOUR
12. L.E. PUBNICO
13. SHORT BEACH
14. SAULNIERVILLE
15. MINK COVE

PRINCE EDWARD ISLAND

1. KINROSS
2. SOURIS



FISH MEAL PLANTS

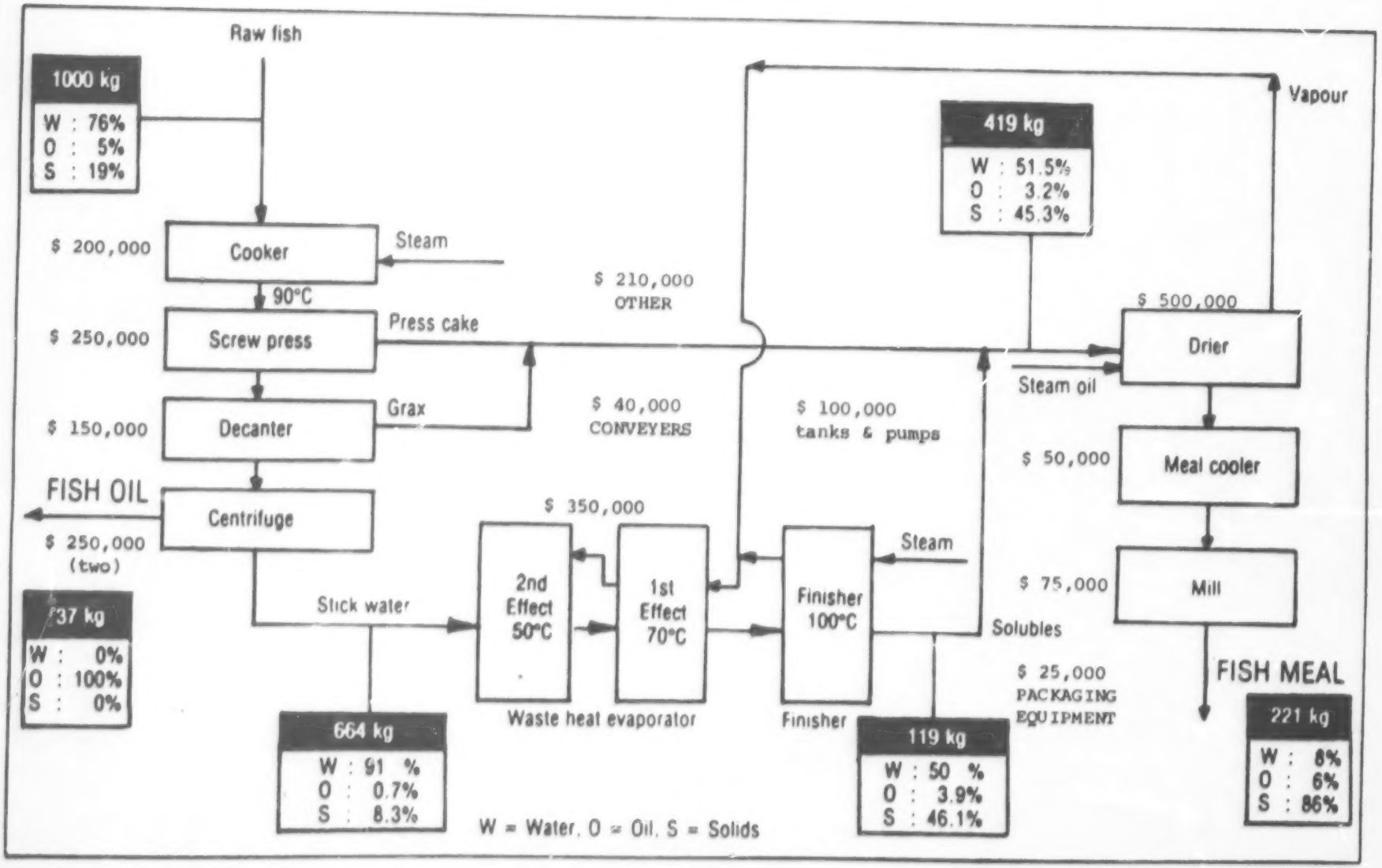
NEWFOUNDLAND:

1. ST. ANTHONY
2. LA SCIE
3. TWILLINGATE
4. VALLEYFIELD
5. BONAVISTA
6. CATALINA
7. CARBONEAR
8. HARBOUR GRACE
9. TREPASSEY
10. RIVERHEAD
11. MARYSTOWN
12. FORTUNE
13. GRAND BANK
14. HARBOUR BRETON
15. GAULTOIS
16. RAMEA
17. BURGEOUS
18. ROSE BLANCHE
19. ISLE AUX MORTS

APPENDIX III

EQUIPMENT COSTS FOR A 100 TONNE PER DAY CAPACITY MEAL PLANT

TOTAL COST = $ 2.2 MILLION



APPENDIX IV

INTERVIEWS

People	Business	Place
FEED PRODUCERS:		
Allan Keras	Ewos Canada Ltd.	Surrey, B.C.
Pierre St.Pierre	Nutribec	Quebec City
Lee Corey	Corey Feed Mills Ltd.	Fredericton, N.B.
FISH PROCESSORS:		
Carl Murphy	USEN Fisheries Ltd.	Souris, P.E.I.
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